1985-03

Evaluation of operation plans using the Joint Theater Level Simulation

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THESIS

EVALUATION OF OPERATION PLANS
USING THE
JOINT THEATER LEVEL SIMULATION

by

Mary Ann McCullen Barrowman

March 1985

Thesis Advisor: Micheal G. Sovereign

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Evaluation of Operation Plans Using the Joint Theater Level Simulation	5. TYPE OF REPORT & PERIOD COVERED: Master's Thesis March, 1985 / 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Mary Ann McCullen Barrowman	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Naval Postgraduate School, Monterey, California 93943	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Naval Postgraduate School, Monterey, California 93943	12. REPORT DATE: March 1985 / 13. NUMBER OF PAGES: 119
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION/ DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Operation Plans, OPLAN, simulation, modeling, JTLS, theater-level, evaluation, war games

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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S N 0102-LF-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Evaluation of Operation Plans using the Joint Theater Level Simulation

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
March 1985

ABSTRACT

The purpose of this thesis is to present a method of evaluating joint operation plans (OPLAN's) using the Joint Theater Level Simulation (JTLS), a theater-level war game which models the functions of air, ground, naval, logistics, and intelligence activities. The thesis outlines the organization and function of the participants and the types of game play possible. The method proposed uses a series of two-sided war games to evaluate aspects of OPLAN's and to identify areas for resolution in new plans. Aspects of OPLAN's which are appropriate for analysis with war gaming are identified. Limitations of OPLAN evaluation using JTLS are addressed and recommended solutions are presented.

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I. INTRODUCTION

It is the policy of the United States to prevent and, if necessary, to react to hostile activities by others. Thus the United States Armed Forces must be able to predict, anticipate, and counter potential threats to the United States. In peacetime, deliberate planning is conducted for the more likely and more resource-taxing contingencies. Operation plans (OPLAN's) are the vehicles by which the United States Armed Forces plan for war during peacetime. OPLAN's are used to identify the planned deployment of forces, the employment of forces in the theater of operations, and the required support during execution. OPLAN's are usually very general and broad to allow application in as many situations as possible. Preparing an OPLAN is a very expensive and resource intensive planning activity. A basic OPLAN written by one unified command may require supporting plans from other unified commands, the specified commands, component commands, and other Department of Defense (DoD) activities.

A. EVALUATION OF OPERATION PLANS

Currently the primary effort in inter-service analytical analysis is conducted by the Joint Analysis Directorate (JAD) of the Organization of the

Joint Chiefs of Staff (OJCS). The Total Force Capability Assessment (TFCA), initiated in 1978, was established for the purpose of developing analytical procedures for the assessment of the total force capabilities of current and projected forces of the United States and its allies. Both the annual assessments and the overall methodology are called TFCA. The general objectives of the TFCA are:

(1) to improve analytical support for the Joint Strategic Planning System (JSPS) and assist in other force assessment efforts.

(2) to provide the means by which assessments can be made of the total capability of the U. S. and Allied Forces to oppose specified threats.

(3) to jointly assess land, sea, and air capabilities.

The methodology employed includes the use of various analytical techniques depending upon the specific objectives within each assessment. Each TFCA generally includes worldwide and regional net assessments, regional static assessments, theater/regional dynamic war games, and supporting analyses and simulations. The interactive, computer-assisted war gaming technique employed at JAD is an open and controlled game. All participants of TFCA know the what, why, and when of occurring events. Everyone takes part in the deliberations and decisions for both sides of the game. The game is a capabilities game to assess; it is not a free-flow what-if game to teach. Nor does it attempt to war game an individual

OPLAN or Concept of Operations. The results of TFCA are used by the participants in their daily work, in preparing and discussing the JSPS and the Department of Defense Planning, Programming, and Budgeting System (PPBS) documents, and as background for special papers and reports. TFCA, as it is presently developed, is not a method for evaluating joint OPLAN's.

The purpose of this thesis is to propose a method of evaluating individual operation plans in the joint arena using the Joint Theater Level Simulation (JTLS), a system recently developed in a joint venture initiated by the United States Readiness Command, the United States Army War College, and the Concepts Analysis Agency. Recently, funding was identified to provide the hardware and software required for JTLS to each unified commander. This could lead to improvements in OPLAN evaluations at the Commander in Chief level. The method proposed in this thesis is a two-sided war game using a separate group of players for each side. JTLS is used for all battle damage assessment and supply consumption and provides the players with a continuous perspective of the war.

Experience has shown that war gaming can be an extremely powerful tool for identifying the critical assumptions, resources, actions, and limiting factors in an OPLAN. Properly structured and correctly utilized,

war gaming can aid in the identification of limitations and weaknesses in a plan.

B. ORGANIZATION OF THESIS

This thesis is divided into six chapters. Chapter II describes the phases of deliberate planning as defined in the Joint Operation Planning System (JOPS). The automatic data processing support available through JOPS is identified as well as the support available at the Transportation Operating Agencies.

Chapter III discusses the design and capabilities of JTLS in terms of its major subprograms, the Combat Events Program, Model Interface Program, Scenario Preparation Program, and Start/Restart Program. Readers who are familiar with JOPS and JTLS can skip Chapters II and III.

Chapter IV identifies the evaluation requirements for four major areas in OPLAN's, preconflict situation, deployment of forces and supplies, employment of forces, and sustainment of forces. In addition, the organization of evaluation with JTLS and its limitations are identified.

In Chapter V, sample evaluation activites are described and structures and procedures are proposed for evaluations using JTLS. Chapter VI

summarizes the recommendations and conclusions and identifies enhancements to JTLS and follow-on efforts in the area.

C. BACKGROUND

The recommendations presented in this thesis are based upon my education and experience. From April 1983 until April 1984, I was assigned as Operations Analyst at the United States Readiness Command Element Monterey (REM) and worked on the design and testing phases of JTLS. Currently, I am assigned as the JOPS/Supporting Plans Officer on the staff of the Commander in Chief United States Pacific Fleet (CINCPACFLT).

II. JOINT OPERATION PLANNING SYSTEM

The Joint Operation Planning System (JOPS) provides the Joint Deployment Community (JDC) with the necessary framework for the preparation and maintenance of operation plans (OPLAN's) during both deliberate and time-sensitive planning. JOPS Volumes I, II, and III outline the procedures for deliberate planning while JOPS Volume IV, Crisis Action System, addresses time-sensitive planning. JOPS consolidates the policies and procedures for the development, coordination, dissemination, review, and approval of joint plans for the conduct of military operations. Only the deliberate planning cycle is addressed in this thesis.

A. PHASES IN OPERATION PLAN PRODUCTION

The production of OPLAN's by the JDC during deliberate planning is divided into five major phases: Initiation, Concept Development, Plan Development, Plan Review, and Supporting Plans. Figure 2-1 diagrams the phases of deliberate planning [Ref. 1]. These phases are described in detail below [Ref. 2].

Phase I.	INITIATION	
	Basis:	National Security Objectives
	Criteria:	The Threat Planning Tasks and Forces
	Objective:	Establish Plan Requirements and Tasking
Phase II.	CONCEPT DEVELOPMENT	
	Basis:	Mission Assignment (Forecast Situation)
	Criteria:	Force and Resource Allocation All Significant Factors
	Objective:	Derive the Concept of Operations
Phase III.	PLAN DEVELOPMENT	
	Basis:	The Commander's Concept
	Criteria:	Force and Resource Allocation Service Planning Factors Strategic Movement Data Concept Adequacy
	Objective:	A Transportation Feasible, Implementation Plan
Phase IV.	PLAN REVIEW	
	Basis:	The Plan
	Criteria:	Adequacy and Feasibility
	Objective:	An Approved Plan
Phase V.	SUPPORTING PLANS	
	Basis:	The Approved Plan
	Criteria:	Service Doctrine Support Agreements
	Objective:	A Family of Plans

Figure 2-1. Phases of Deliberate Planning

1. Phase I - Initiation

The Joint Strategic Planning System (JSPS) is used to translate the national security policy into strategic guidance, direction, and objectives for force structuring, resource programming, and operational planning. The primary document for operational planning produced by this system is the Joint Strategic Capabilities Plan (JSCP). JSCP Volume I outlines the military strategy and Volume II identifies the force allocations. The JSCP annexes provide additional planning guidance. Through JSCP, the Joint Chiefs of Staff (JCS) assign missions to the commanders of unified and specified commands and identify and apportion the major combat forces and JCS-controlled resources that are available for planning. Additional information is provided on replacement personnel and planning factors for gross calculations of resupply, airlift and sealift asset allocations, and plan submission schedules and dates. Service planning documents identify other combat, combat support, and combat service support forces that are not allocated through the JSCP.

2. Phase II - Concept Development

The second phase begins with the collection and analysis of factors which can significantly affect mission accomplishment. The supported commander defines the detailed mission objectives and disseminates

guidance to his staff and subordinate commanders. This guidance provides information regarding the expected enemy and friendly forces, the capabilities and likely situations, the political aspects, and the nuclear and chemical warfare considerations for planning. The commander and his staff prepare staff estimates on alternative courses of action (COA's). Separate staff estimates are normally prepared for personnel, intelligence, operations, logistics, and communications which provide the commander with an analysis of the situation and a comparison of the COA's. The supported commander then determines the best COA and prepares a Commander's Estimate, which provides the analysis of the alternate COA's and outlines the chosen COA. The COA is then expanded to form the Concept of Operations which defines the deployment and employment of forces, required combat and logistics support, and command relationships for the operation.

3. Phase III - Plan Development

During this phase of the deliberate planning cycle, the basic plan and the supporting annexes to the OPLAN are prepared. The required elements in an OPLAN are identified in Figure 2-2 [Ref. 2]. This phase is conducted for all OPLAN's and any Concept Plans (CONPLAN's) which require specific Time-Phased Force Deployment Data (TPFDD). The Plan Development

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Annex M, Mapping, Charting, and Geodesy
Annex X, Execution Checklist
Annex Z, Distribution

Figure 2-2. Basic Elements in an Operation Plan

phase is divided into the eight steps identified below. These steps can be accomplished simultaneously or repeated as necessary. Figure 2-3 presents an overview of the steps in plan development.

a. Force Planning

The initial force TPFDD, encompassing the first ninety days of deployment, is developed in this step of the cycle. This requires the determination of force requirements, the development of the force list, its refinement based on availability, and the initial identification and resolution of force shortfalls. The TPFDD should include all assigned, augmenting, and supporting forces to be deployed or stationed in the area of operations.

b. Support Planning

During support planning, all support requirements for sustainment of the forces in combat are determined and incorporated in the TPFDD by the Service components. The requirements are items such as spare parts, subsistence, weapons, and ammunition. The ten Department of Defense (DoD) classes of supply are identified in Figure 2-4 [Ref. 1]. Support requirements are determined on the basis of Service planning factors and are then time-phased to ensure supplies are available as needed by the combat forces.

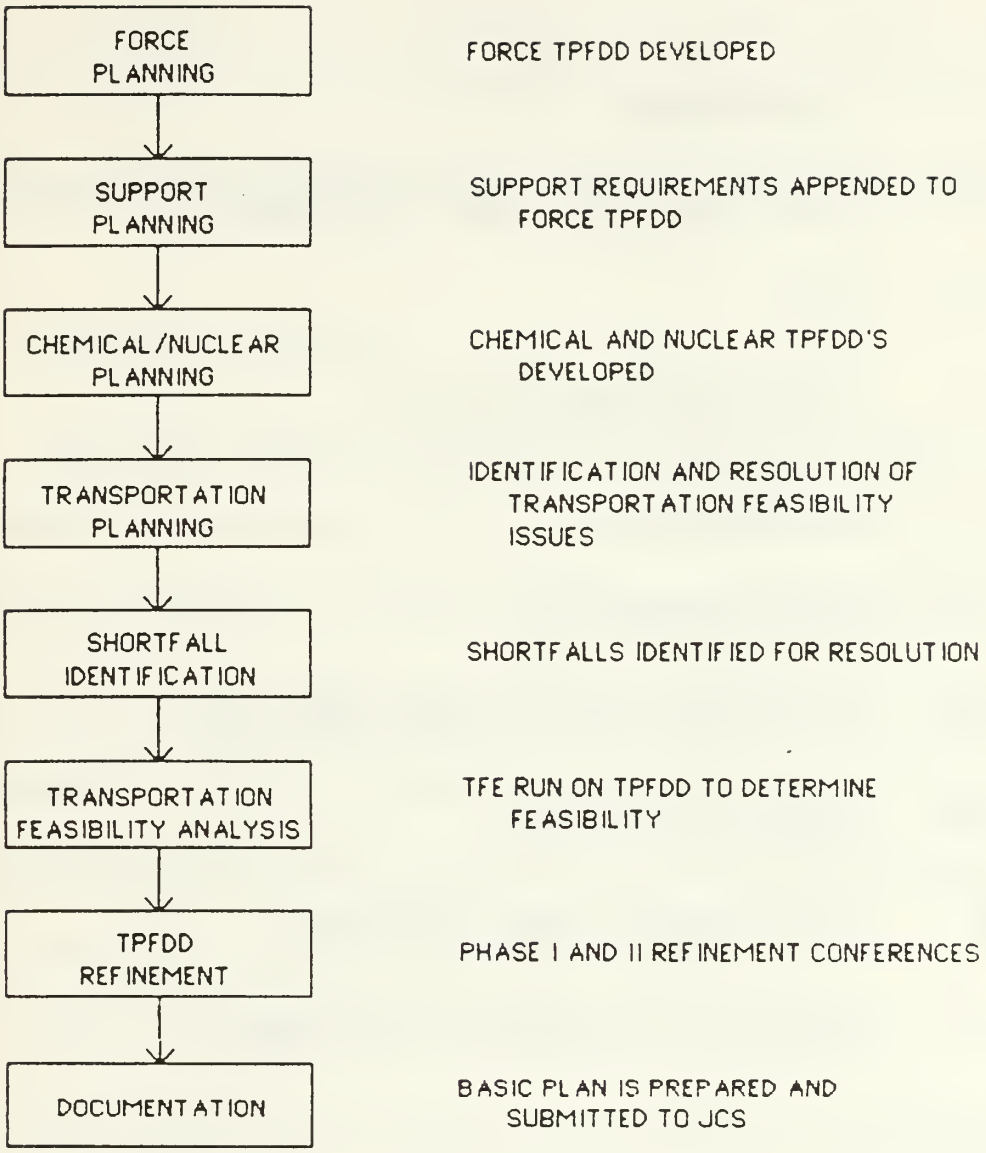

Figure 2-3. Plan Development Phase

I	SUBSISTENCE
II	INDIVIDUAL EQUIPMENT - CLOTHING, ETC.
III	POL
IV	CONSTRUCTION MATERIALS
V	AMMUNITION
VI	PERSONAL DEMAND
VII	MAJOR END ITEMS - TANKS, VEHICLES
VIII	MEDICAL MATERIALS
IX	REPAIR PARTS AND COMPONENTS
X	NONMILITARY PROGRAM MATERIALS

Figure 2-4. DoD Classes of Supplies

c. Chemical/Nuclear Planning

A separate TPFDD is prepared that incorporates the time-phased chemical requirements. The time-phased nuclear requirements are identified and passed to the Joint Deployment Agency (JDA) and Military Airlift Command (MAC) for incorporation in the Joint Deployment System (JDS).

d. Transportation Planning

The primary purpose of this step is to identify and resolve any gross transportation feasibility and related issues. Transportation planning concentrates on planning the movement and reception of manpower, material, and equipment from ports of embarkation (POE's) to ports of debarkation (POD's). Competing requirements are assessed in terms of their impact on mission accomplishment and priorities are established to ensure a workable transportation plan is produced for the OPLAN.

e. Shortfall Identification

The identification and resolution of shortfalls is an on-going step throughout the Plan Development phase. Once identified, the force and non-unit-related cargo and personnel shortfalls are submitted to JCS as a separate TPFDD. Shortfall resolution can be accomplished by such means as

modification of priorities, adjustments in routing and lift modes, or redefinition of the concept of operations.

f. Transportation Feasibility Analysis

In this step of the Plan Development phase, the Transportation Feasibility Estimator (TFE), a computer simulation hosted on the World Wide Military Command and Control System (WWMCCS), is run on the TPFDD to determine if the plan is grossly transportation feasible.

g. TPFDD Refinement

This step begins when the initial TPFDD is ready for review. The TPFDD must be made available for review to the JDC at least 30 days prior to the Phase I Refinement Conference. (Note: The TPFDD is refined in two conferences, Phase I and Phase II. These two phases are not the defined Phases I and II of deliberate planning discussed previously but are contained within Phase III, Plan Development.) The two primary purposes of the conference are (1) to coordinate the inclusion of actual or best available data (identifying sources for the requirements) and (2) to coordinate the resolution of force and non-unit-related personnel and cargo shortfalls. After the Phase I Refinement Conference, the Transportation Operating Agencies (TOA's) analyze the transportation feasibility of the refined TPFDD. After the TOA's have conducted their analyses, the Phase II

Refinement Conference is convened. At this conference, the transportation requirements and shortfalls and the approval of the TPFDD closure profile are coordinated with the supported commander and movement schedules and tables are appended to the TPFDD. Once this refinement is complete, the JDA transfers the TPFDD to the JDS deployment data base for plan maintenance.

h. Documentation

Once the TPFDD is refined, the supported commander completes the basic plan and all of its annexes. The draft OPLAN is then submitted to JCS for review. Figure 2-2 identified the basic elements required by JOPS in an OPLAN.

4. Phase IV - Plan Review

All elements of an OPLAN are accessed and validated by JCS during this phase in the deliberate planning cycle. The JCS criteria for approval of an OPLAN are adequacy and feasibility. The review for adequacy determines whether the scope and concept of planned operations are sufficient to accomplish the tasks assigned and assesses the validity of the assumptions and compliance with the JCS tasking and guidance.

The review for feasibility determines whether the assigned tasks can be accomplished utilizing the available resources. The primary factors

considered are the appropriateness, availability, and planned use of resources made available for planning by the JSCP and Service planning documents.

5. Phase V - Supporting Plans

This phase encompasses the completion, documentation, and validation of all supporting plans. Supporting plans are prepared to identify how the command will accomplish the missions assigned by the supported commander. All required supporting plans must be submitted to the supported commander within sixty days of the JCS approval of the supported commander's OPLAN. The supported commander is the review and approval authority for the supporting plans. Information contained in the supported commander's plan does not need to be repeated in the supporting plans. Figure 2-5 represents the tasking of the basic OPLAN and the supporting plans [Ref. 1].

6. Plan Maintenance

Plan maintenance is not one of the defined phases but is an important part of the deliberate planning cycle. The purpose is to keep the TPFDD current by incorporating needed changes, such as routing and unit identification, into the data base. During plan maintenance, the first fifteen days of air movements and the first thirty days of sea movements are

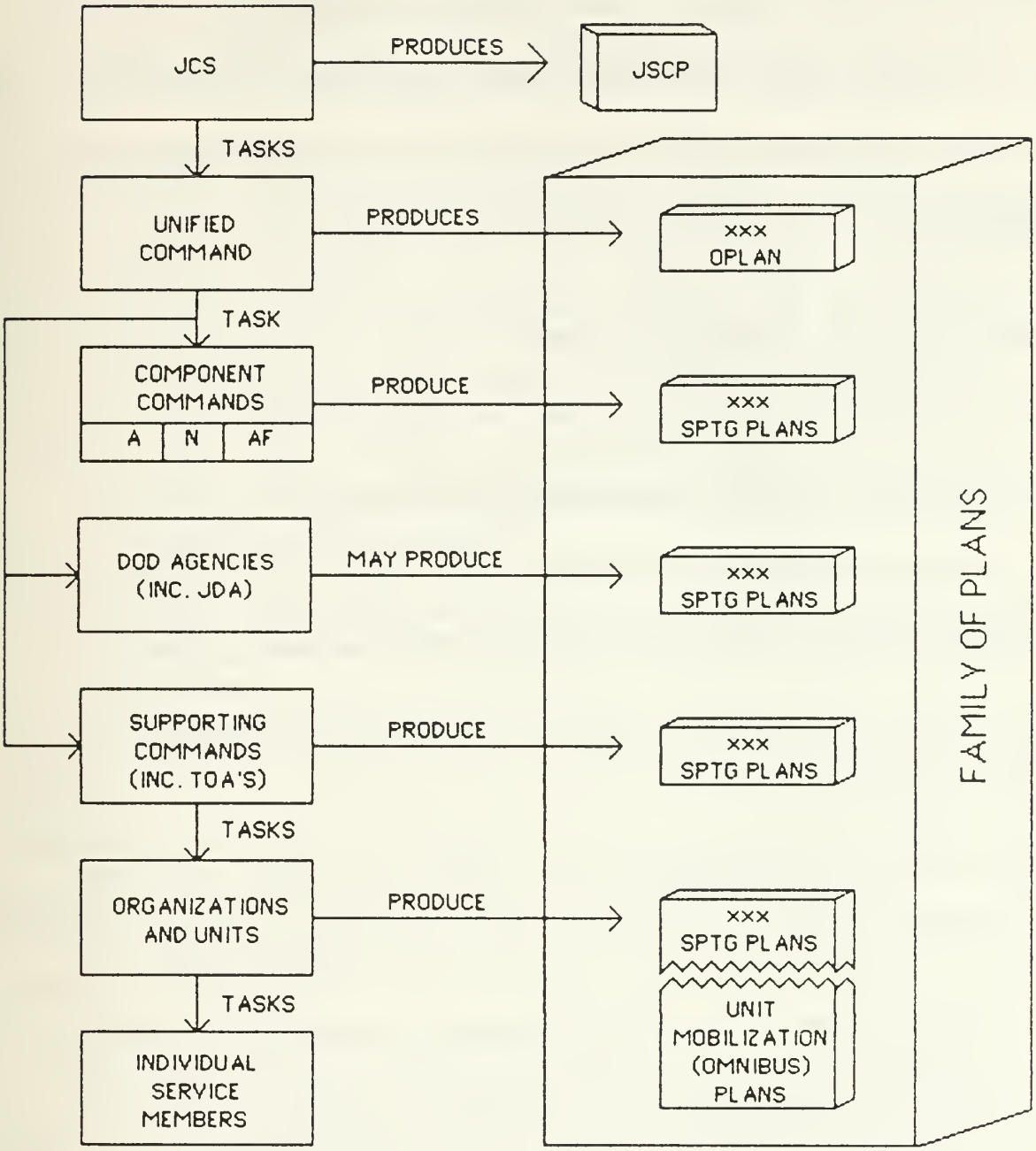

Figure 2-5. Supporting Plans

examined and modified based on current guidance and capabilities. This is done to reduce the number of data base updates required prior to execution. Each refined TPFDD should be "maintained" every four months beginning after the Phase II refined TPFDD is available to the JDC.

B. AUTOMATIC DATA PROCESSING SUPPORT

The Joint Operation Planning System provides automatic tools to be used by the JDC during the deliberate planning process to develop, analyze, refine, review, and maintain joint OPLAN's and to prepare supporting plans. The automatic data processing (ADP) support in JOPS includes standard data files and application programs. A sample of the data files and programs are described below [Ref. 3].

One of the most important data files in JOPS is the TPFDD. The TPFDD contains the planned deployment of forces and the required support for OPLAN implementation. It is used to disseminate the deployment planning data among the unified and specified commands, the Service components, the Services, the TOA's, and other members of the JDC. The TPFDD contains five general types of data:

(1) Force requirements data, which identifies the combat, combat support, and combat service support units.

(2) Force movements characteristics data, which provides unit movement characteristics, cargo detail, and cargo category detail information for units that require common-user transportation.

(3) Non-unit-related cargo characteristics and routing data, which identifies estimates and provides origins for required supply, resupply, military support for allies, support for nonmilitary programs, retrograde, and other cargo, including subsistence, individual clothing and equipment, petroleum, oil and lubricants (POL), construction materiel, ammunition, medical materiel, major end items, repair parts, and materiel to support military programs.

(4) Non-unit-related personnel characteristics data, which provides estimates on required fillers, replacements, medical evacuees, and retrograde and other personnel.

(5) Movement table data, which provides information regarding the scheduled movement to the POE, intermediate location, POD, and destination.

Together, this data identifies each force and logistics requirement, its recommended routing, and, through the force movement and cargo and personnel characteristics, aids in determining what vehicles are capable of moving the requirement.

The Aerial Ports and Air Operating Bases File (APORTS) contains the physical and flight operating characteristics of air facilities in the Free World. The data includes aircraft arrival and departure rates, runway characteristics, aircraft parking spaces, and fuel storage capacities.

The Civil Engineering Files (CEF) provide the construction planning data used as an input to the Civil Engineering Support Plan Generator (CESPG).

These files include data on unit-allocated facility requirements, construction and repair capabilities, facility component definitions, and construction planning factors.

The Characteristics of Transportation Resources File (CHSTR) provides the planners with various characteristics of airlift and sealift resources. Airlift characteristics include utilization rates, passenger carrying capacities, cargo payloads, and average load, off-load, and en route delay on ground times. Speed, draft, length, load capacity, load and off-load rates are some of the characteristics provided for sealift resources.

The Transportation Assets File (ASSETS) provides the number of available transportation resources for military and commercial transportation vehicles by type and mobilization condition. The Port Characteristics File (PORTS) contains characteristics, such as port and harbor descriptions, for all shipping ports in the Free World.

The Type Unit Data (TUCHA) File contains planning data on movement characteristics for unit personnel, equipment, and accompanying supplies associated with standard deployable units. Logistics resupply and replacement personnel planning factors are contained in the Logistics Factors File (LFF). The Type Unit Equipment Detail File (TUDET) includes the

physical characteristics, such as model number, length, height, square footage, and volume of certain equipment items.

These files are used as inputs to or are outputs from the application software available in JOPS. The Force Requirements Generator (FRG) assists planners in originating, analyzing, and modifying TPFDD's. The Movement Requirements Generator (MRG) determines gross non-unit-related movement requirements for inclusion in a TPFDD. The CESPG is used to determine the feasibility requirements, manpower adequacy, and materiel requirements to support the forces. The Medical Planning Module (MPM) helps planners to determine the gross feasibility of an OPLAN in terms of medical support. The TFE is used to evaluate the gross transportation feasibility of an OPLAN.

The TOA's have developed additional ADP support for use in more detailed analysis of the transportation feasibility and implementation of OPLAN's. MAC has developed the Integrated Military Airlift Planning System (IMAPS) which is used to develop airlift plans. Military Traffic Management Command (MTMC) uses the Mobility Analysis and Planning System (MAPS) to prepare movement tables and identify the preferred seaports and airports. Military Sealift Command (MSC) determines the required ship resources for

OPLAN execution using the Strategic Sealift Contingency Planning System (SEACOP).

C. SUMMARY

The primary concern of the Joint Operation Planning System is the feasible deployment of forces and supplies to the areas of operation. The feasibility of employment is only broadly addressed and analyzed through JOPS. All ADP support is provided to aid in the identification and analysis of the transportation and logistical requirements for the theater operations. This is an extremely important part of operation plans, especially for the Army and the Air Force, but more analysis is warranted of the employment phase of the plans.

III. JOINT THEATER LEVEL SIMULATION

The Joint Theater Level Simulation (JTLS) was established as a joint venture between the United States Readiness Command (USREDCOM), the United States Army War College (USAWC), and the Concepts Analysis Agency (CAA). The objectives of JTLS are to provide a contingency planning analysis tool for USREDCOM and CAA and an educational war game capability for USAWC. JTLS was developed by the Jet Propulsion Laboratory under a contract with USREDCOM. The Naval Postgraduate School (NPS), under a Memorandum of Understanding with USREDCOM, provided the first test bed for the system. JTLS version 1.0 is now installed at USAWC, CAA, and NPS.

JTLS was developed using the capabilities of the McClintock Theater Model (MTM) as a minimum baseline. The simulation was designed for use at the theater level of operations; the players are the equivalent of the theater commander and his staff. JTLS tracks the location and status of all units and simulates combat and combat-related events initiated by the players. JTLS simulates the activities of ground and air units and, to a lesser degree, those of naval units. JTLS does not attempt to model the

decision-making process of the theater commander. It only attempts to simulate the results of decisions as input by the players.

JTLS executes on a Digital Equipment Company (DEC) VAX 11/780 and was written primarily in SIMSCRIPT II.5 with some portions in FORTRAN and DEC command language (DCL).

A. SYSTEM OVERVIEW

JTLS is an interactive war game that allows for free play of air, ground, naval, logistics, and intelligence activities. It consists of four separate, interacting computer programs: the Combat Events Program (CEP), the Model Interface Program (MIP), the Start/Restart Program (S/RP), and the Scenario Preparation Program (SPP). Other subsystems, such as graphics, replay, and post-game processors are either under development or scheduled as future enhancements to the system.

The CEP is the heart of the entire system. It is responsible for the coordination and implementation of all simulated activity from unit movements and supply consumption to battle damage assessment. The CEP was written by Rolands and Associates of Monterey, California. The MIP furnishes the players with a user-friendly interface with the CEP. Players are able to issue orders to units and check on their status through

interaction with the MIP. The S/RP is used to initially start the system, execute a smooth stop in game play, and restart the simulation from any previously saved position. The SPP is designed to build and maintain the large data bases required by JTLS.

B. COMBAT EVENTS PROGRAM

The Combat Events Program is organized in five major functions: ground, air, naval, logistics, and intelligence. These major functional areas provide the simulated movement, battle damage assessment, supply consumption, resupply, weapon effects, status, and mission activity for each of the units involved in the game.

The principal data structure in JTLS is the unit. Units are differentiated primarily by type, i.e., ground combat unit, air base, squadron, naval unit, or support unit. Some of the unit attributes are defined for all types of units. Examples include the unit's name, higher headquarters, average speed, tactical thresholds, location, and wet and dry carry capacity. Other attributes are required only for specific types of units. For example, unique attributes for air bases include the length of the runway and the number of parking spaces while squadrons are defined by characteristics

such as type and number of aircraft, the maximum number of sorties per day, and its designated home base.

JTLS does not currently provide an automated analysis tool. The system does however generate the Major Event History File to aid the evaluators in post-game analysis. This file is created during game play and contains a brief synopsis of the major activities which have occurred. The file can only be accessed when the game is not executing. The events captured in the file are listed below:

(1) requisition and receipt of supplies

(2) launching of aircraft

(3) results of air to air combat

(4) results of air to ground assessments

(5) results of air defense attrition

(6) destruction of air missions

(7) initiation of ground combat

(8) termination of ground combat

(9) change in unit posture

(10) unit arrivals

(11) incremental unit arrivals

(12) strategic logistic arrivals

The theater's terrain is represented by a series of interconnecting hexagons (hexes), six-sided polygons. The game area is segmented into numerous hexes; the number required depends upon the size of each hex and the size of the theater of operations. Figure 3-1 presents an illustration of a small insert from a JTLS hex map. Each hex is defined by its location, size, interior terrain, elevation, and side barriers. Additionally, other characteristics such as radar coverage are hex-related attributes. Types of terrain that can be represented include forests, deserts, oceans, mountains, roads, and cities. The terrain, along with the unit's speed and the density of units within the hex, determines the rate of movement of a unit through the hex. Side barriers can delay or prohibit a surface unit's movement from hex to hex. Types of barriers are open terrain, rivers, wadis, tank ditches, bridges, and impassable barriers. Impassable barriers are used to prohibit movement out of the theater of operations or from a land mass to the ocean. The terrain values and barriers do not affect the movement rate of aircraft although elevation can prohibit its movement through a hex.

Unit movement is not continuous, but occurs in jumps as a unit moves from hex to hex. The smaller the hexes, the less movement distortion occurs. The time required to execute many of the JTLS routines, such as route optimization, are directly proportional to the number of hexes in an

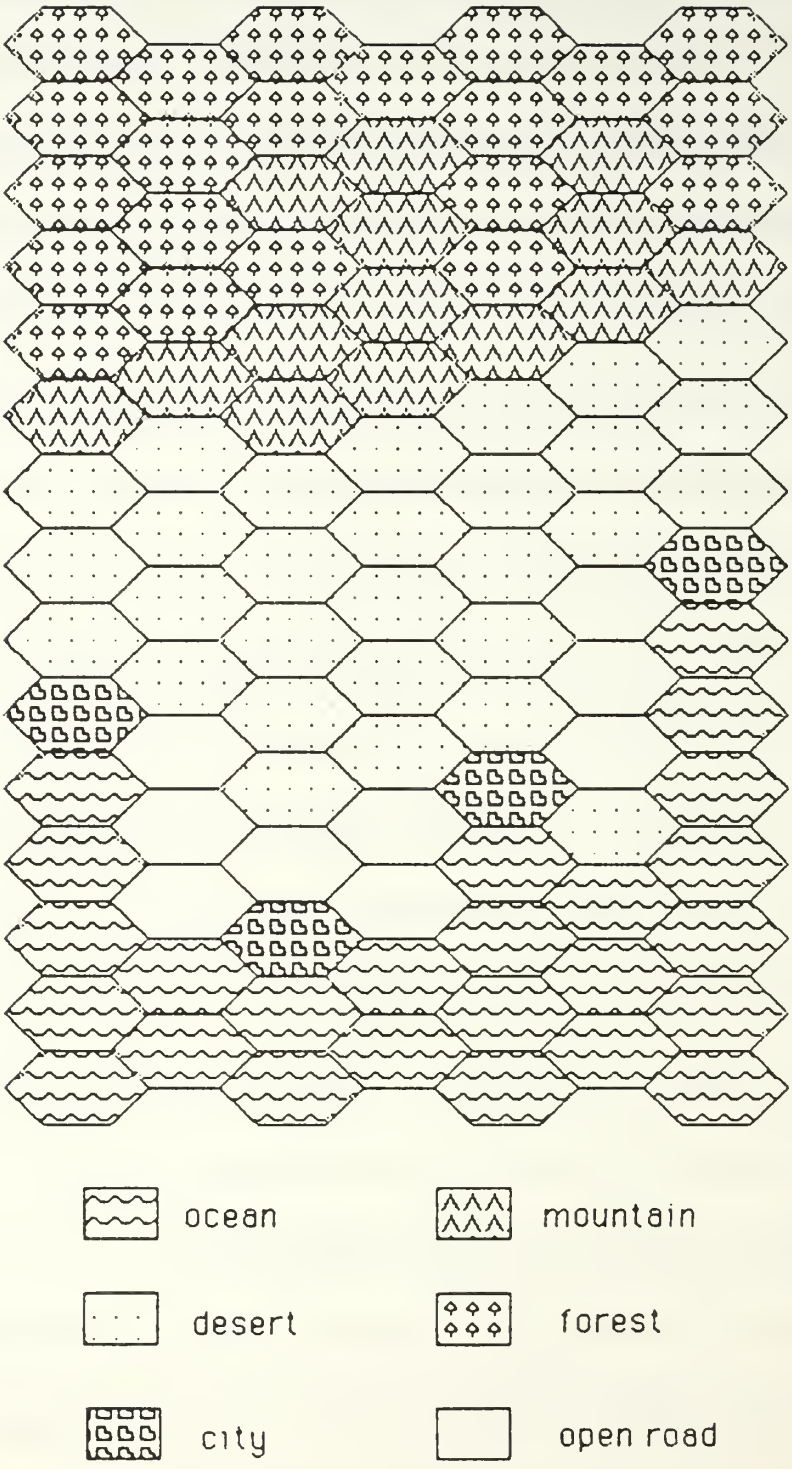

Figure 3-1. Sample Hex/Terrain Map

area. Small hexes will minimize the movement distortion but will increase the memory requirements and the execution time.

JTLS contains a limited representation of command, control, and communications (C3) activities within the theater. Orders are sent to units by the theater commander. The time required for orders to reach the unit depend on its physical distance from higher headquarters and its organic C3 capability. Additionally orders may be subject to jamming by the enemy, which increases the time before receipt of orders. Orders can be intercepted by the enemy forces but this does not affect the delivery time. Both jamming and interception are based on simple probabilities. Communication between units other than the headquarters of the theater commander is not modeled in JTLS. The communication difficulties between units of different services are not represented and cannot be evaluated.

1. Ground Module

Ground units in JTLS have been designed to represent divisions or their counterparts. A ground unit is defined in terms of its Table of Organization and Equipment (TO&E), its current state, and its assigned mission. The TO&E specifies each unit's configuration at full strength by weapon system, supply, and personnel resources. The current state of the unit is a measure of its actual configuration. Examples of missions which

can be assigned to ground units are attack, defend, delay, fire, and clear mines. The available missions for assignment are detailed in section C.2. If a ground unit is given an order to attack, defend, or delay, the unit attempts to remain in the ordered posture until it completes the assigned mission or is no longer physically able to maintain the required posture. A data parameter called tactical threshold is used to determine when a unit is no longer able to sustain its posture. The tactical threshold value is compared to a measure of the units current strength as a percentage of its capacity at full strength. For example, suppose unit A has an attack to defend tactical threshhold of 85 percent and is ordered to attack unit B. Unit A will continue to attack unit B until unit B is destroyed, unit A is ordered to break contact, or the current state of unit A falls below 85 percent of its full strength.

When a ground unit is required to move, either administratively or to achieve a certain posture, the movement can be optimized over distance or time (i.e., the shortest distance or the least amount of time). The default optimization is time. The movement time of a unit is affected by the defined speed of the unit and the terrain and barriers associated with the hexes in its path.

A unit is not allowed to occupy the same hex with a enemy unit. If opposing forces occupy adjacent hexes, combat will begin. Land combat in JTLS is deterministic and is modeled by mixed, heterogeneous Lanchestrian differential equations. The data tables, consisting of Lanchester coefficients, can be as general or as specific as the evaluation requires. The tables can provide a set of weapon attrition coefficients to be used for all cases or different cases depending on the conditions, such as time of day and weather condition.

2. Air Module

The air module simulates the activities of land-based and naval air in the theater of operations. There are two primary types of units associated with the air module: squadrons and air bases. A squadron is composed of a single type of aircraft and is stationed at an air base. The air base furnishes logistical support for all of its squadrons. Before aircraft can launch, the air player must assign a mission by issuing one of the air directives identified in section C.3.

Many of the same parameters are used in all of the air mission types. Examples are number of aircraft required, designated squadron, time-over-target (or comparable equivalent), alternate air base, ingress and egress routes, and weapons or supply load. Once a mission directive has

been issued, the air module determines if launch is possible. The launch is delayed or canceled if there are insufficient aircraft, weapons, fuel, or supplies available. If the mission is launch capable, the launch is scheduled based on the time required to load the aircraft and fly to the destination and the time-over-target requirement in the mission parameters. Once airborne, the mission flies to its first designated location via its ingress route, performs its mission, flies to the second location, if any, and returns home via its egress route. Aircraft consume fuel during flight and, if more fuel is required, attempt to refuel. Air missions search for tankers and air bases in the area which have fuel available. The mission refuels from the source that causes the least delay in mission accomplishment. Once a mission has landed, the remaining weapons and fuel are off-loaded and the aircraft go into a maintenance cycle.

Air missions strive to avoid enemy air defense sites if possible. A user defined parameter specifies how far missions can go out of their way to avoid the sites. Damage inflicted by air missions is stochastically modeled in all cases except close air support (CAS), which is part of the quick reaction alert-offensive air support (QRA-OAS). During a CAS mission, the value of the air support is added to the supported ground force's Lanchester coefficients.

3. Naval Module

The naval module in JTLS is the least developed module in the system. Most of the activities of naval air are adequately modeled in the air module with the exception of the anti-submarine warfare (ASW) forces. The simulated activities of naval ships have not been developed to a satisfactory degree. Ships have the capability to move, fire surface-to-surface missiles, and turn their radars on and off. These capabilities are modeled very simply and are not detailed enough for OPLAN evaluation of naval surface forces. There is no simulation of naval subsurface forces.

4. Logistics Module

The logistics module simulates the effects of logistics on combat capability. Logistics can affect the combat capability of a unit in several ways. Aircraft, for example, must have sufficient fuel and weapons prior to launch. Once airborne, aircraft are required to obtain needed fuel or they are not able to complete the mission. The status of the equipment, personnel, and supplies of a ground unit is directly related to the calculations of attrition coefficients for the Lanchester difference equations. An excellent discussion of the attrition calculations can be found in JTLS Analyst Guide [Ref. 4].

Most events in logistics are automatically scheduled by the CEP and require little direct player action. The TPFDD function models the arrival of forces into the theater of operations. When a unit arrives in the theater (through a scheduled TPFDD event), a "top-level" supply depot issues the required personnel and equipment to the unit. The unit consumes supplies based on its usage rates. Some supply categories are consumed based on the number of people in the unit (i.e., pounds per man per day) and the unit's posture. Other categories, such as air ammunitions and air fuel, are decremented when used by the units. Supplies can also be defined with a daily usage rate. Each day, or other period defined in the data base, a unit determines the supply categories that have been used and the current levels of each. If a category has dropped below its reorder level, the unit requisitions those supplies, up to its stockage objective, from its supporting depot. The depot schedules the movement of those supplies, if they are available, by the depot's organic lift. Every defined period the supply depots requisition supplies from their supporting depot. The "top-level" depots recieve supplies from strategic lift arriving in the theater through LOGIN events. (The LOGIN function simulates the effect of strategic lift, host nation support, and prepositioned supplies.) This sequence of events simulates the logistics pull philosophy.

The push philosophy is also accommodated in JTLS. If the unit's reorder level and stockage objectives are set to zero, supplies are not sent to the unit as a result of requisitions. The logistics player can then provide PUSH directives for the unit which create a designated supply load that is automatically sent to the unit at the user specified time intervals.

5. Intelligence Module

The intelligence module provides each side with the capability to collect intelligence and derive essential elements of information. A major source of intelligence information in JTLS is the national and strategic intelligence summaries which are produced by the intelligence module. These reports provide the name and location of detected enemy units and targets in the theater of operations. Reports are also provided by units and missions operating in the theater. This information includes the current location and posture of enemy units and the status of targets.

Covert collection by infiltration and unconventional operations by armed forces personnel is modeled through the HUMINT directive. Human intelligence (HUMINT) missions are sent to a specified location for a designated length of time to report any enemy activity in the area of coverage. The intelligence module reports only factual information. Distortion and misinformation are not simulated in JTLS.

C. MODEL INTERFACE PROGRAM

The Model Interface Program provides the controller and players with a user-friendly interface with the CEP. There are five types of MIP's: controller, command, air, logistics, and intelligence. The number of MIP's required in a game or exercise is dependent on the number of players available and the scope of the game. Once a game is initiated with a specified MIP configuration, it cannot be changed. The number of MIP's executing during game play can vary from three, the minimum configuration, to nine, the maximum configuration. In the minimum configuration, there is one controller MIP and one MIP each for the friendly and enemy commanders. In the maximum configuration, there is one controller MIP and one MIP each for command, air, logistics, and intelligence for the friendly and enemy sides. The MIP's can be configured to support one or a combination of functional areas. The nine acceptable combinations are defined below:

(1) Controller

(2) Command

(3) Air

(4) Logistics

(5) Intelligence

(6) Air and Logistics

(7) Air and Intelligence

(8) Logistics and Intelligence

(9) Air, Logistics, and Intelligence

The primary function of the MIP's is to correctly format orders passing from the players to the CEP and to check orders for consistency and validity. It also provides the means for players to query the CEP on items such as unit status and provides a communication link between the players and the controller. The MIP's also provide output to players from the CEP. The CEP provides periodic summaries of major activities which have occurred during the period and intelligence summaries which list all targets and units detected. Messages are sent to the players through the MIP's when certain activities occur. Examples of these activities include when a unit cannot comply with an order, when a unit completes a move, when an air mission is launch capable or has landed, and when combat is initiated. These summaries and messages can be seen on the terminals through the MIP's and can be printed. If the output is longer than the maximum specified in the data base, it will automatically be printed and not sent to the MIP.

The MIP's have two types of directives that can be developed by the players. The first is a directive that causes the CEP to schedule an event such as an aircraft launch. The second type of directive prepares

supporting data for other directives. Examples of supporting directives are air and ground routes and weapons loads for air missions.

1. Controller Model Interface Program

The game controller is a mediator between the players, the CEP, and the real-world battle simulation. The controller is always aware of game truth and is able to interactively change modeling parameters and unit characteristics. The Controller MIP provides the controller with the following directives and queries: GAME SPEED, SEND, SAVE, TPFDD BUILD, TPFDD DELETE, LOGIN BUILD, LOGIN DELETE, TARGET MOVE, TARGET CREATE, and SITREP. The controller is able to set the preferred game speed, the ratio of game time to real time, with the GAME SPEED directive. The system attempts to match but not exceed this value. Often, due to the system load, it is not be able to attain the preferred speed. The SEND directive enables the controller to prepare and send messages to some or all players through their MIP's. The SAVE directive is used when the controller wishes to save the game parameters and history. This saved position can be used to restart the system at a later time. The TPFDD BUILD and TPFDD DELETE directives are used to build or delete TPFDD events during the simulation. TPFDD events are normally unit arrivals and include the time of arrival and the location of the unit and its equipment. The LOGIN BUILD and LOGIN DELETE

directives work much the same way for LOGIN events, arrivals of strategic supplies to the theater. The TARGET MOVE and TARGET CREATE directives allow the controller to move existing targets or to create new targets in the theater. The controller is able to determine the current status of any or all units through the SITREP command.

2. Command Model Interface Program

The primary purpose of the Command MIP is to enter ground and naval directives and queries. This MIP also has the capability of entering air, logistics, and intelligence directives and queries. The air, logistics, and intelligence directives are discussed in succeeding sections.

The ground directives available for the commander are MOVE, ATTACK, DEFEND, DELAY, WITHDRAW, TACTICAL THRESHOLD, FIRE, CANCEL FIRE, MINE, CLEAR MINES, REPAIR TARGET, and GROUND ROUTE. The MOVE, ATTACK, DEFEND, DELAY, and WITHDRAW directives are used to order a specified unit to assume a designated posture. Using the TACTICAL THRESHOLD directive, the commander can designate the threshold at which a unit changes postures, such as from attack to defend or from delay to withdraw. The FIRE directive orders a unit to fire on a designated location or target for a specified duration. CANCEL FIRE can cancel any previously issued FIRE directive. The commander can order a unit to lay mines in a

certain area using the MINE directive or to clear the mines out of a designated area using the directive CLEAR MINES. A unit can be ordered to repair a target using REPAIR TARGET. The repair can be completed if the unit specified has the required amount of equipment in the appropriate supply category. The GROUND ROUTE directive is used to define a preferred route for events requiring movement, i.e., attacking and withdrawing.

The directives available for naval functions are SEALIFT, MISSILE, RADAR, NAVAL MOVE, and SEA ROUTE. The SEALIFT directive orders a naval unit to pick up a designated unit or supply load at the indicated location and move it to a destination. The commander has the capability to order a naval unit to fire a missile at a specified bearing using MISSILE and to turn on or off its air and sea radars with the RADAR directive. The NAVAL MOVE directive causes a naval unit to move to a specified location using the designated SEA ROUTE. The functions available for the utilization of naval air assets are incorporated in the Air MIP.

3. Air Model Interface Program

The Air MIP has a large number of available directives. These include AIRBORNE WARNING AND CONTROL SYSTEM (AWACS), COMBAT AIR PATROL (CAP), AIR REFUEL, QUICK REACTION ALERT-DEFENSIVE COUNTER AIR (QRA-DCA), QUICK REACTION ALERT-OFFENSIVE AIR SUPPORT (QRA-OAS),

RECONNAISSANCE (RECCE), ARMED RECCE, AIR-GROUND ATTACK, AIRLIFT, AIRDROP, AIR MISSION PACKAGE (AMP), WILD WEASEL, ELECTRONIC COMBAT (EC), ESCORT, REPLACEMENT, CHANGE ALTERNATE AIR BASE, CANCEL AIR MISSION, WEAPONS LOAD, AIR ROUTE, and AIR SUPPLY LOAD.

The AWACS, CAP, AIR REFUEL, QRA-DCA, QRA-OAS, RECCE, ARMED RECCE, AIR-GROUND ATTACK, AIRLIFT, AIRDROP, AMP, WILD WEASEL, EC , and ESCORT directives are used to launch one or more aircraft and define the details of the mission and its parameters. The AWACS, CAP, and AIR REFUEL missions work in much the same way. In each of the missions, one or more aircraft are ordered to orbit between two coordinates. The AWACS mission searches for incoming enemy aircraft and directs assets from either CAP or QRA-DCA missions to intercept. The CAP aircraft orbit in an airborne alert status and provide quick reaction intercept capabilities against enemy aircraft detected by AWACS, ground radars, or their organic radars. AIR REFUEL missions orbit in their designated area and supply aircraft in the vicinity with fuel as required. The QRA-DCA missions perform the same functions as the CAP but are on ground vice airborne alert. QRA-OAS missions provide ground alert aircraft for close air support to ground units in combat.

RECCE and ARMED RECCE aircraft are directed to fly from a first location to a second location and report any detected enemy activity. ARMED RECCE aircraft fire upon the first appropriate enemy target located along the route. The AIR-GROUND ATTACK mission is used to direct aircraft to bomb a designated target or set of coordinates. The player has the option of selecting a second target in case the first target was not detected. The AIRLIFT and AIRDROP directives are used to lift or drop units or supplies to a specified area.

The AMP allows the player to group different types of aircraft into a single supporting mission. This package is most often built around an air-ground attack. The WILD WEASEL mission provides protection from air defense sites by suppression or destruction if possible. The EC aircraft are used to suppress enemy radar. Both the WILD WEASEL and EC missions can be used as individual missions. The ESCORT mission can only be used as part of an AMP. ESCORT supplies fighter escorts for protection from enemy air interceptors.

The REPLACEMENT directive is used to designate aircraft for use as replacements in airlift and airdrop missions when the original aircraft assigned are unable to complete the mission in a reasonable time. The CHANGE ALTERNATE AIR BASE directive allows the air player to designate an

alternate air base for emergency situations. The player can cancel an air mission before it launches using the CANCEL AIR MISSION command. The WEAPONS LOAD, AIR ROUTE and AIR SUPPLY LOAD directives are used as supporting directives for applicable missions.

4. Logistics Model Interface Program

The directives available to the logistics player are CROSSLEVEL, DIRECTED RESUPPLY, PUSH, PUSH DELETE, CHANGE DEPOT, STOCKAGE OBJECTIVE, REORDER LEVEL, LOGISTICS LOAD, and LOGISTICS ROUTE. CROSSLEVEL enables the logistic player to transfer specified amounts of each category of supplies from one unit to another. The two units must be within a defined distance from each other for implementation of this directive. The player can directly resupply a unit from a depot with the DIRECTED RESUPPLY order. The PUSH directive is used to build the supply reserves of a unit by sending a designated supply load at defined time periods. The PUSH DELETE directive cancels a previous PUSH command. A unit can be directed to change its supporting depot using the CHANGE DEPOT directive. The STOCKAGE OBJECTIVE and REORDER LEVEL directives are used to change or report a unit's stockage objectives and reorder levels by category of supplies. The LOGISTICS LOAD and LOGISTICS ROUTE directives are supporting directives.

5. Intelligence Model Interface Program

The Intelligence MIP has only one directive, HUMINT. This directive is used to send intelligence units to specified locations to report on any enemy activity. The intelligence player has a wide variety of reports available. These include the Strategic Intelligence Report, National Intelligence Report, tactical daily summaries, units reports, and the reports from RECCE and ARMED RECCE missions.

D. START/RESTART PROGRAM

The Start/Restart Program is used by the controller to initially start JTLS and to restart the system from planned or unplanned shutdowns. During game play, the controller can save the game data through the Controller MIP. This can be done automatically based on user specified time periods between saves or can be done manually whenever the controller feels it is necessary or prudent. These previously saved positions in game play can be used to restart the game. This can be invaluable when evaluating different courses of action or strategy or when an unplanned shutdown occurs.

E. SCENARIO PREPARATION PROGRAM

The Combat Events Program contains no data parameters. This makes the development of the detailed data base for JTLS a large scale project. The data items required are as diverse as the probability of kill in good weather by a certain weapon system to the time of sunrise. The SPP was developed to aid in data base development, verification, and modification. The SPP is essentially a large data base manager. The SPP enables the user to enter the data in a forms mode, check the data for consistency, and produce a data base in the format required by the CEP. Once an initial data base is developed, its parts can be used, in any logical combination, to build a data base for a new scenario.

The SPP segments the data base into five primary groups: force unit data, weapon system/target characteristics data, logistics data, environmental data, and scenario parameters. The force unit data defines LOGIN and TPFDD events, target attributes, and each unit and its combat systems, supply categories and consumption. The weapon system/target characteristics data identifies every type of weapon system (i.e., aircraft, sensor packages, emitter suites, and Lanchester cases) and the characteristics and attrition coefficients of each. The logistics data provides general parameters such as the class and weight of each supply

category, conversion factors, and the load and off-load times. The environmental data defines general environmental parameters and identifies each hex in the theater by its location, elevation, terrain, and barriers. The scenario parameters contain data that pertains to all units and missions in the scenario such as the probabilities of detection, message jamming and delay parameters, and the random numbers seeds required by the simulation.

F. SUMMARY

The Joint Theater Level Simulation, as its name implies, is a model for theater-level operations. JTLS, in its current form, can be used to simulate such activities as the movement from the POD to the destination, the flow of supplies and personnel to the units, and the combat effects of ground and air units. The detail available in JTLS should be sufficient for many aspects of operation plan evaluations. The simulation is designed for ease of understanding and handling by staff officers, which should enhance its capability for use in OPLAN evaluations.

IV. OPERATION PLAN EVALUATION

Operation plans, as shown in Figure 2-2, are very broad documents providing general implemention guidance for activities ranging from nuclear operations to mortuary services. The organization of operation plans, while excellent for providing guidance to units, is not suitable for evaluation purposes because of the interdependence of the parts. Thus, a different organization for operation plan evaluations, based on the operational phases, is proposed below. Additionally, methods for use of JTLS in operation plan evaluation are identified along with a structure for the war game organization.

A. PHASES OF OPERATION PLANS

For the purpose of this thesis, OPLAN's have been divided into four general phases: (1) preconflict situation, (2) deployment of forces and supplies, (3) employment of forces, and (4) sustainment of forces. Each of these phases is critical to successful OPLAN execution. The preconflict situation phase encompasses the activities that occur before the decision is made to execute a particular OPLAN. The deployment of forces and supplies phase includes the mobilization of resources and their movement to the

required locations. The employment of forces phase represents the actions of the forces in the theater. Sustainment of forces includes the flow of personnel and supplies to the forces in the theater.

1. Preconflict Situation

The events that occur during this stage are the activities that lead up to the decision to execute an OPLAN. Intelligence activities play a major role during this phase. The collection and analysis of intelligence data often provide the first indication that world or regional events may be leading to a crisis situation. Various military and nonmilitary courses of action and OPLAN's are evaluated to determine if they are appropriate for the situation. The activities in this phase are most often evaluated through the use of command post exercises (CPX's). These exercises are used to evaluate the decision-making processes and the information flow between major commands, especially those in the JDC. CPX's often evaluate the command, control and communication (C3) activities at the higher level commands, especially the effectiveness of the joint support systems and procedures such as the World Wide Military Command and Control System (WWMCCS), the Crisis Action System, and the Joint Deployment System (JDS). These activities cannot be evaluated with JTLS.

2. Deployment of Forces and Supplies

A tremendous amount of effort is spent during the deliberate planning process on the deployment requirements for the forces and their supplies. The movement of forces and supplies is normally segregated into three legs: the origin to the POE, the POE to the POD, and the POD to the destination. In most cases, the transportation from the origin to the POE is supplied by a supporting Commander in Chief (CINC), MTMC, or the unit's own organic transportation assets. The movement from the POE to the POD most often utilizes MAC, MSC, or organic lift resources. Transportation from the POD to the destination is normally provided by the unit's organic or the supported CINC's theater lift assets. Every movement requirement in the TPFDD is defined in terms of these three legs and the time schedules. The time schedules are defined by the unit's ready to load date (RLD) at the origin, its available to load date (ALD) at the POE, its earliest arrival date (EAD) and latest arrival date (LAD) at the POD, and its required delivery date (RDD) at the destination. Together the origin, POE, POD, destination, RLD, ALD, EAD, LAD, and RDD define the route and schedule for every transportation requirement in the OPLAN.

During the plan development phase of deliberate planning, the supported commander identifies, through the TPFDD, all forces required to

accomplish the assigned missions and determines when each force is required to be in the area of operations. The required support for the forces is included in the TPFDD. The TPFDD is then used as an input to the Transportation Feasibility Estimator which determines if the plan is grossly transportation feasible. The TOA's (MAC, MTMC, and MSC), using the refined TPFDD from the Phase I Refinement Conference, analyze the transportation requirements using their in-house transportation analysis tools, IMAPS, MAPS, and SEACOP. Transportation shortfalls and discrepancies are resolved at the Phase II Refinement Conference and the final movement tables and schedules are appended to the TPFDD. The refined Phase II TPFDD is generally considered transportation feasible; the identified combat, combat support, and combat service support forces and their resupplies are assumed to be able to arrive at the theater of operations in the time frame designated in the TPFDD. Shortfalls that cannot be resolved are itemized in a separate TPFDD.

The preponderance of this analysis effort is directed towards the transportation requirements from the POE to the POD, the major portion of the TOA's lift responsibilities. The movement from the POD to the destination is an area of deployment that requires further analysis and evaluation. OPLAN evaluation should determine if the units and supplies

arriving at their POD in the theater can be moved to their destination by their organic or the theater's lift assets by the required date.

The analysis tool used for intratheater deployment evaluation should consider several variables associated with the lift resources required, whether organic or theater, to move units and supplies. Elements that should be represented are lift capacity and speed of the transportation asset, effects of geography on movement, and susceptibility to enemy interdiction. JTLS could be used for the POD to destination transportation evaluation.

3. Employment of Forces

There is no ADP support currently available within JOPS to aid in determining if the force levels are adequate or if the concept of operations is appropriate to accomplish the assigned missions. The model used for OPLAN evaluation of the employment area should be able to simulate a wide range of combat-related activities. The model should portray a realistic picture of the theater and the on-going operations. The model should adequately simulate force activities such as movement, combat attrition, conventional and nonconventional weapon systems, and supply consumption.

4. Sustainment of Forces

Providing the logistical requirements for forces in combat can be as important as the combat capability of the units. Logistics planners must ensure that adequate supplies arrive in the theater of operations and that those supplies get to the units that require them. The deployment of supplies to the theater, as discussed in section A.2, is evaluated extensively by the JOPS and the TOA analysis support tools. The distribution of supplies to units within the theater requires further analysis and evaluation. Additionally, the effects of shortfalls and delayed delivery of logistics support to the combat units and the resultant degradation in mission accomplishment requires identification and quantification. This can help identify cargo categories that are critical to the evaluated OPLAN so that appropriate measures can be taken at execution to ensure delivery.

B. USE OF JTLS IN OPLAN EVALUATION

War gaming, as with any stochastic process, is unable to determine if the execution of an OPLAN will always result in mission success. The events related to execution of an OPLAN contain a vast number of random elements and the outcomes of probabilistic events cannot be known in

advance. Evaluations should be able to identify general trends in the execution of a plan.

OPLAN evaluation cannot be adequately accomplished with one or two war games. The evaluation process for large OPLAN's should be continuous from the time of the plan's Phase II Refinement Conference through the Concept Development Phase of the new version of the plan. In addition to the joint, theater-level evaluations conducted by the supported commander, evaluations should be performed by the component commanders. The results of these evaluations could be used to evaluate, in more detail, specific aspects of a plan such as the ASW scenario. The results of all evaluations should be used as input to the next version of the plan and for other plans if applicable.

One of the most important contributions to the successful execution of a campaign, leadership, cannot be adequately modeled. Even so, war gaming can be a powerful tool for identifying the critical actions, resources, and assumptions in an OPLAN. Properly structured and correctly used, war gaming should aid in the detection of limitations and weaknesses in a plan.

1. Modes of Operation

JTLS was designed as an extremely flexible tool. For example, no numerical parameters are contained within the code; all values are supplied

through the data base. This allows a scenario to be finely tailored based on the force and logistics structure of the plan and the requirements of the evaluation. Another design feature within JTLS that promotes flexibility is the variable MIP configurations. This allows a war game to be played with as many as nine or as little as three data input terminals. Due to this flexibility, there are several different methods for structuring war games with JTLS.

Because of the execution time required by the system, it is not always efficient or appropriate to integrate the full capabilities of JTLS in every war game. Every operation plan is unique, with different assumptions, missions, force levels, etc. Because of this uniqueness, one specified structure would not be appropriate for all evaluations. Both the operation plan and the aspects that require evaluation must be analyzed to determine which structure is most accommodating. Possible structures are discussed below.

a. Functional Segregation

Because of the flexibility of the data base, segregation of the functional areas can be accommodated in JTLS. One game structure that could be used would eliminate the simulated effects of logistics on the game. If this option was adopted, the game director must be willing to

assume that the effects of logistics do not significantly impact the result of the missions and the chosen MOE's. This option can be easily accomplished through simple modifications of the data base. The consumption rates for each of the units should be set to zero. Additional manipulation is required of the units' reorder levels, stockage objectives, and carry capacities to ensure proper performance. This option would be appropriate in scenarios where transportation and logistics resources are not critical, i.e., prepositioned supplies are sufficient for the operation. This option can also be used as a first-cut look at the plan.

The air function in JTLS requires an extensive amount of computer time and can reduce the game speed significantly. Any possible separation of air activities from the war game can enhance the model's performance in this respect. Using this option, appropriate air functions could be gamed with JTLS prior to the start of the war game and the results of missions saved. The remaining functions, ground, naval, and logistics, could then be played using the Controller to input the results of the previously simulated air activities into the model at the appropriate times. Some air functions should not be segregated this way due to their direct interaction with the other functional areas. For example, close air support missions and air-ground attack missions with units as targets should be

played concurrently with the ground function. Air-to-air combat and air-ground attacks on targets such as bridges and air fields could be played separately and the results entered into the game through the Controller MIP at the appropriate time. These two options, segregation of logistics and air functions, should be used in the beginning of the evaluation cycle to help identify major points of interest that require further evaluation.

A third option is to play all functions simultaneously. This should provide the most valid results as it allows for the full integration and interaction of all of the functional areas.

b. Segregation by Operational Phases

Evaluation of operation plans with JTLS can also be segregated by operational phases: deployment of forces and supplies, employment of forces, and sustainment of forces. The initial deployment of forces and supplies from the POD's to the destinations can be evaluated with a minimal team of players prior to initiation of a full war game. During this stage, the units could arrive in theater at their POD's and begin their movement to their destinations. Minimal air play would be required, thus improving the game speed. Once the majority of units are in place and before combat begins, the game can be saved for restart when full play commences. Since the units are moving and the supply lines are being set up and filled, when

full play commences, most of the units would have arrived at their destinations with full supply lines. The evaluation of employment and sustainment of theater forces can be separated by functional areas as discussed previously.

2. Game Organization

The game play with JTLS, as proposed in this thesis, is organized as a two-sided game with experienced participants on both sides. Figure 4-1 outlines the proposed organization. The participants should include the Game Director, the Data Base Preparation Team (DBPT), the Evaluation Team, the Controller/Support Group, and the Blue and Red Teams. To ensure efficient use of participating personnel, the duties and responsibilities of the players should be established and promulgated early in the evaluation process cycle. The Game Director functions as an overall coordinator for the exercise. The DBPT is responsible for preparing and verifying the JTLS data base prior to the war game. The data collection required for post-game analysis is provided by the Evaluation Team. The Controller/Support Group provides the day-to-day exercise control and implementation once the war game has begun. Use of the Controller/Support Group for implementing orders and queries should minimize the possibility of testing the Blue and Red Teams' ability to play JTLS rather than testing the the operation plan. This group

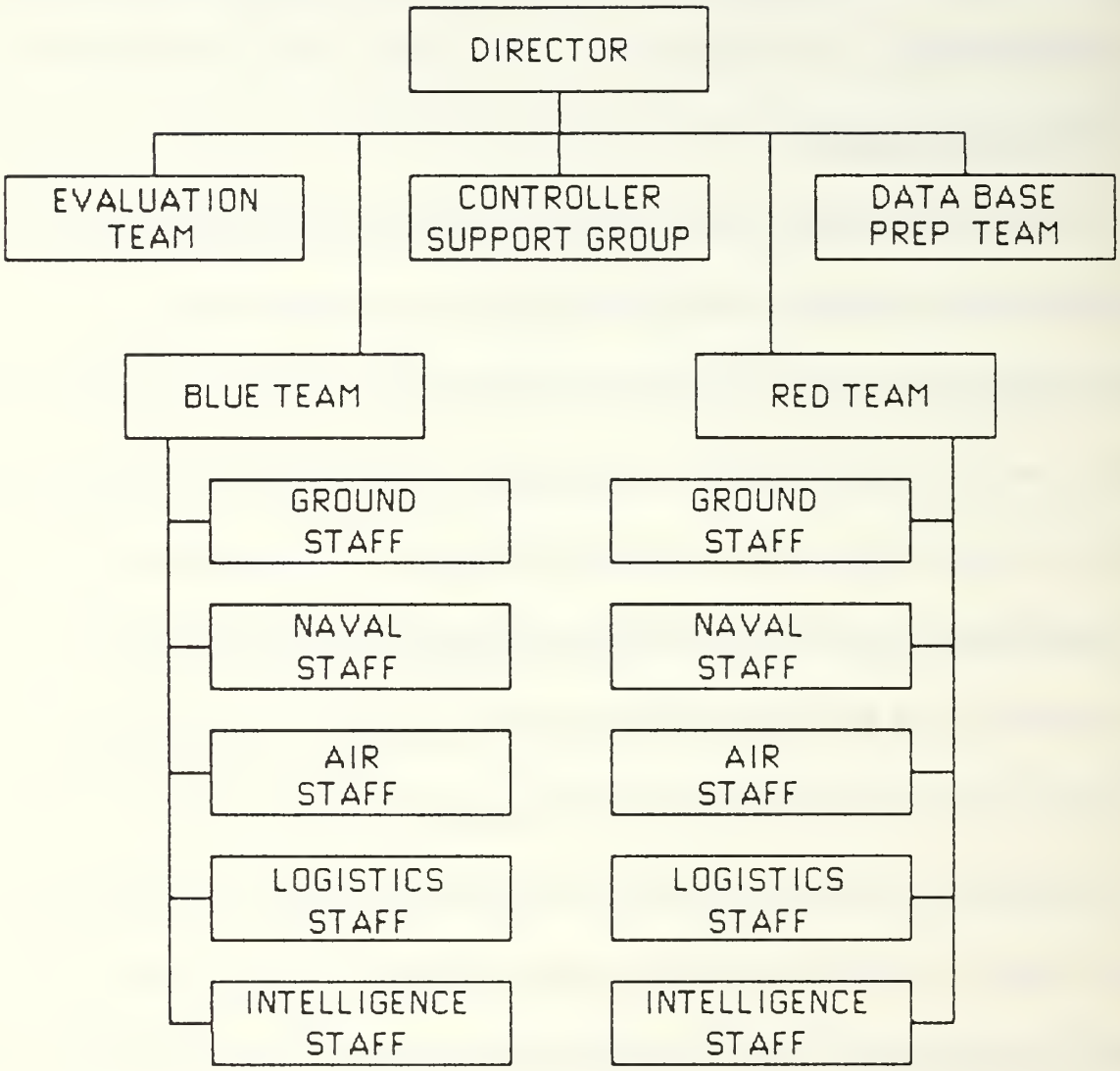

Figure 4-1. Proposed Organization of the War Game

should be composed of at least one person for every active MIP in the game. The Blue and Red Teams function as the opposing battle staffs. Using separate teams for Blue and Red ensure that the players do not have perfect information. This introduces into the game more of the realism of human decision-making required during the implementation of a plan. The Game Director, DBPT, Evaluation Team, and Controller/Support Group should be knowledgeable in JTLS. The functions and responsibilities of the participants are discussed in further detail below.

a. The Game Director

The Game Director has overall responsibility for the OPLAN evaluation and the structure of the war game. The Game Director should have a general understanding of war gaming and be very familiar with the operation plan to be evaluated. The activities to be accomplished by the Game Director are identified as follows:

(1) Define the objectives of the evaluation.

(2) Define the activities, assumptions, etc. of the plan that are to be evaluated during the war game.

(3) Prepare a game book which outlines the overall strategy for friendly and enemy forces, assumptions of the game, and instructions for the participants.

(4) Act as higher authority for the Blue and Red Teams.

(5) Approve the OPLAN Evaluation Report.

b. The Data Base Preparation Team

The primary function of the DBPT is to translate the data from the OPLAN, especially the TPFDD, into the data structures and formats required by JTLS. The DBPT should have a thorough understanding of the JTLS data base and how the data is used within the model. The team should use the game book prepared by the Game Director to ensure data structures are appropriate for supporting the evaluation. The preparation of the data base includes the following activities:

(1) Define all units that are active in the game and their characteristics.

(2) Define the supply categories that will be used and those supply items that require individual tracking.

(3) Define the weapons systems required by the theater forces.

(4) Identify the required Lanchester cases and attrition coefficients.

(5) Acquire terrain data for the theater.

(6) Prepare a target list.

(7) Translate all data into the format required by JTLS and prepare the data base using the SPP.

(8) Check the data by exercising the war game to ensure that the events are realistic.

(9) Using the SPP, prepare Blue and Red Team notebooks by functional area outlining all units, weapons, etc. that are available for use by the theater commander.

c. The Evaluation Team

It is the responsibility of the Evaluation Team to ensure that the defined MOE's are evaluated during game play. The Evaluation Team should have a strong analysis background to ensure that appropriate MOE's are used and to correctly evaluate the results of the game. The activities required are:

(1) Determine the appropriate measures of effectiveness and specify the thresholds for success.

(2) Determine the proper structure of the game play to enable successful evaluation of the identified MOE's.

(3) Define any required actions to be accomplished by the Blue and Red Teams.

(4) Determine the data collection requirements and prepare a method of data collection for use during game play.

(5) Identify all data base modifications required during game play.

(6) Monitor the activities during the exercise and modify events as necessary.

(7) Collect and analyze the data.

(8) Identify any weaknesses and limitations of the OPLAN based on the evaluation and areas which require further evaluation.

(9) Prepare a final evaluation for the Game Director.

d. The Controller/Support Group

The primary responsibility of the Controller/Support Group is to monitor game execution, implement directives on the player MIPs, and provide modifications to the data base as required by the scenario. This group should be very familiar with the operation of JTLS. The functions of the Controller/Support Group are as follows:

(1) Start JTLS initially, restart the game as required, and save the game when necessary.

(2) Keep the Game Director and Evaluation Team informed on the state of game truth and provide preliminary assessments.

(3) Ensure that the Blue and Red Teams are following the assumptions and guidance in the OPLAN as modified by the Game Director.

(4) Ensure game speed is set to accomodate both the players and the game requirements.

(5) Redefine parameters and force attributes as required.

(6) Translate the requirements of the Blue and Red Teams into directives and queries for JTLS and provide the results to the appropriate team.

e. The Blue and Red Teams

The Blue and Red Teams will be composed of the theater commander (team leader), ground staff, naval staff, air staff, logistics staff, and intelligence staff. The Blue Team should be composed of personnel with understanding of the kinds of operations to be executed and

the appropriate rules of engagement. The personnel on the Red Team should have knowledge of the philosophy, strategy, and weapons systems used by the Red forces. In most cases, the Red Team should consist primarily of intelligence personnel. Depending upon the scope of the evaluation and upon the level of staff activities, these functions may require one or more persons per staff or some staffs may be grouped together. The teams are responsible for the implementation of the force strategy as outlined in the OPLAN and modified by the Game Director. The teams are responsible for the following activities to implement the defined strategy:

(1) Move units to the destinations defined in the TPFDD, if required.

(2) Set up force actions to accomplish the required missions.

(3) React to the combat as the game progresses.

(4) Provide comments to Game Director and Evaluation Team as required.

C. LIMITATIONS OF EVALUATION WITH JTLS

There are several aspects of OPLAN evaluation that cannot be adequately accomplished by JTLS. One of the most critical limitations for joint operations is the lack of naval activities. JTLS in its current form is unable to simulate the functions of ASW or amphibious landings and does not contain a unit structure suitable for submarine forces. Other naval

functions such as ship-to-ship combat are too simplified to be of much use in evaluations. JTLS could be used for operation plan evaluation of theaters where naval play is limited or where naval missions are distinct and have little interaction with other forces.

Another critical limitation is the inability of JTLS to adequately evaluate the C3 capability of the theater forces. Orders that are sent to units can be delayed, jammed, or intercepted based on a probability factor. The delay time is based on the distance to the unit, its internal C3 capability, and whether or not the message was subject to jamming. The simulation does not model the C3 problems that arise between units due to incompatible equipment. Interoperability can be a significant problem when dealing with joint forces.

War games with JTLS are limited to the forces employed in one theater due to the area limitations within the model (approximately 2000 by 2000 miles). The theaters can be successfully evaluated separately provided there is only limited interaction between the them.

JTLS is a war game composed of many stochastic processes. Because of these probablistic events, results of games must be analyzed to ensure that they are reasonable and not due to a bad random number seed. In addition, variability due to the Blue and Red Team's inexperience in strategic

decision-making, as well as the possibility of bad decisions, must be analyzed with the game's results.

D. SUMMARY

Using the Joint Theater Level Simulation to evaluate certain aspects of OPLAN's may lead to the identification of limiting factors and weaknesses in the plan. The Game Director and the Evaluation Team should be careful during an OPLAN evaluation to ensure that the plan itself is tested rather than the players' ability to play the game. Using the organization proposed in this chapter, this problem should be minimized. The Controller/Support Group provides all direct interaction with the model thus relieving the players (Blue and Red Teams) from having to learn the system and allowing them to concentrate on the game decisions. The Game Director must realize that the results of one war game are simply the results of one iteration of play. General trends of limitations and weaknesses identified in a series of games should warrant study and further analysis. Although some results may not be optimal due to imperfect decisions by the players, this is a realistic element of actual execution of the war plans.

JTLS may be of use in evaluating many aspects of operation plans such as Army and Air Force combat operations, consumption and resupply of

equipment and supplies, and intratheater deployment. Measures of effectiveness that depend heavily on naval forces should not be evaluated by the current version of JTLS. The evaluation results are heavily dependent on the accuracy of the data base and an extensive effort to obtain reliable data is required. The development of OPLAN's is close to a perpetual process. Almost as soon as the basic plan and its supporting plans and annexes are approved, work begins on the new version of the plan. Because of the data requirements in JTLS, evaluations should be conducted on stable plans. By the end of the Phase II Refinement Conference, the concept of operations, the force and logistical requirements, and the transportation feasibility of the plan have been established. At that time, valid data is available for conversion and input to JTLS and the evaluation cycle should begin. The results of these evaluations should be used during the initial planning of the revised version of the OPLAN.

V. OPERATION PLAN EVALUATION ACTIVITIES

Operation plans can be evaluated in several different ways. The methodology proposed in this thesis defines a two-sided war game which uses JTLS to simulate the actions directed by the friendly and enemy commanders. To provide further insight into the game organization and structure discussed in Chapter IV, a sample evaluation is provided. In addition, several aspects of operation plans that can be evaluated with JTLS are included for amplification.

A. SAMPLE EVALUATION

This sample evaluation provides a discussion of the activities and events related to operation plan evaluation and how they can impact new plan development. Appendix C, War Game Checklist, provides a summary checklist for pre-war game, war game, and post-war game activities.

1. Scenario

A friendly country, **A**, is bordered on two sides by a hostile country, **B**, whose long range goals include the invasion and subjugation of **A**. The United States has agreed to help defend **A** and has produced an OPLAN for this contingency. The OPLAN is to be executed upon National Command

Authority direction when it is determined that A is in near-term danger of invasion by B.

A is a long distance from the United States. The concept of operations provides considerable force augmentation and, thus, execution of the plan requires significant levels of airlift and sealift resources for the deployment of forces and supplies.

The primary objective of the plan is to prohibit B from taking over A. The strategy developed to accomplish this objective is to augment the borders and deter all invasion attempts.

2. The Evaluation Process

The Game Director responsible for the evaluation of the plan must first determine what aspects of the plan require further study. In this case, we will assume that the strategy is a controversial issue. One group is a proponent of the current strategy of remaining within the borders of A to defend the country. Another group believes that this defense of A will not work and, in order to defend A, the friendly forces must move and attack into B. Deployment is also of interest in this plan. The current plan is transportation feasible given the apportioned lift assets. If other contingencies arise in other parts of the world at the same time, lift assets may be reapportioned to other areas. These two areas, strategy and lift

apportionment, are identified by the Game Director as appropriate for evaluation. The two areas are interrelated; the level of augmentation of forces and supplies to the theater of operations can have a very significant impact on the implementation of the strategy.

The next step in the evaluation process should be the development of appropriate measures of effectiveness. MOE's are composed of two parts; the criteria to be measured and the threshold of success. The Evaluation Team determined the primary MOE's in this case to be:

number of **B** forces inside **A** at day 180 < 4000

AND

per cent of U.S. forces killed in action by day 180 < 3%

In addition, the Evaluation Team can identify secondary MOE's. These MOE's can be used to measure success at various points in the game or can be used to assess secondary missions and objectives. The MOE provided above is not proported to be an appropriate MOE but is provided only as an example of a measureable MOE. MOE's are discussed in further detail in section B.3.

Four different scenarios are identified by the Game Director:

(1) offensive strategy with full lift apportionment.

(2) defensive strategy with full lift apportionment.

(3) offensive strategy with reduced lift apportionment,

(4) defensive strategy with reduced lift apportionment.

Scenarios one and two could be played with one data base. Small modifications to the unit destinations may be necessitated by the strategy change. This data base can be developed primarily from the plan's TPFDD. Scenarios three and four should be played with a modified data base. The Game Director and DBPT, with the aid of the TOA's (MAC, MSC, and MTMC) must determine the new level of lift resources and the modifications to the arrival times of forces and supplies in the theater. This data will then be used to modify the original data base used in scenarios one and two.

Once the data base has been developed, it should be tested prior to the start of the evaluation. During this testing, units should be moved and engaged in combat, aircraft should be launched, etc. to identify and correct errors in the data base. Examples of errors that can be easily identified are:

(1) An air squadron is stationed at an air base with a 1000 foot runway. The aircraft require a 5000 foot runway. These aircraft are unable to launch or land at their home base.

(2) A certain unit's allocated equipment and supplies weigh 2000 tons but its carry capacity is set to 100 tons. When this unit attempts to move, it leaves 95% of its material and may become an incapable unit.

The evaluation of the two identified issues should be conducted through a series of war games. The first war game in the series should be a

quick run through of the operation to help identify major problem areas that may require more detailed analysis. This initial game should be functionally segregated to eliminate the effects of logistics and possibly air (See Chapter IV, Section B.1 for further discussion). The results of this game can indicate whether or not the concept of operation is realistic when logistics is not a factor. It can also identify limitations in the strategy and inadequate force levels. Operations that do not succeed when the effects of logistics are not included will probably not succeed when the limitations of logistics are considered. The Game Director and Evaluation Team should use the results of the first war game to structure and evaluate the succeeding games. The four scenarios identified above should be used as the basis for the succeeding games.

The games should be structured enough to allow for valid evaluations but should be flexible enough to recover from unexpected events. For example, if there is a major upset in the operations that strongly indicates that the mission will not succeed, the Game Director, Evaluation Team, and Blue and Red Teams should modify the strategy, logistical constraints, etc. to provide corrective action. Less value will be accrued from continuing to play a losing game. Instead, the game should be

restarted from a previous checkpoint and new actions taken to discover a viable plan.

3. Evaluation Results

The results from the war games should be prepared as a formal report for the supported commander of the OPLAN. This report should include a description of the war game, its assumptions and limitations, the aspects that were evaluated, the results, and recommendations for further evaluations and modifications to the OPLAN. This report should identify any known sensitivities in the results as well as an estimate of the validity of the results. These reports, along with the basic plan, could be used as a basis for developing the next version of the OPLAN.

B. EVALUATION ACTIVITIES

In order to more accurately portray some of the activities that can be evaluated in operation plans with JTLS, some examples are provided. The examples provided include discussions regarding defining the measures of effectiveness, testing of assumptions, observing the flow of a critical supply item and its effect on combat effectiveness, and determining if units can move to their destinations by their required delivery dates. Using these

examples, the evaluation structures are defined and proposed procedures are identified.

1. Measures of Effectiveness

Appropriate measures of effectiveness are critical to a successful plan evaluation. Prior to an objective evaluation of a specific OPLAN, the criterion for success must be well quantified. The results of evaluations are extremely sensitive to the chosen MOE's. The measures of effectiveness (MOE's) for each aspect requiring evaluation must be determined. For example, one of the missions in an OPLAN may be to protect commercial shipping transiting through an area. Should the measure of success be defined as the number of ships or the tons of cargo lost? What are the values that determine success and failure? The MOE for the same type of mission can vary between OPLAN's and even within the same plan. In one OPLAN, protection of shipping may be very important due to the impact of late or lost deliveries on mission accomplishment. The tons or percentage of cargo lost may be the most appropriate MOE. In another, the determination of success may be more politically oriented and the number of ships lost might more accurately represent the MOE for success or failure. As well as specific mission accomplishment, the evaluation may attempt to determine if the OPLAN makes efficient use of the available

forces and should identify the most critical assumptions affecting its ability to succeed.

The war games could have several MOE's to be evaluated. Some MOE's may be designated as major items while others may be of less importance. Major MOE's could be related directly to the success or failure of an OPLAN. Minor MOE's could be used to evaluate other aspects such as deployment within the theater, utilization of forces, or communications.

Another structure for multiple MOE's could be the establishment of primary, secondary, and even tertiary MOE's. This structure of MOE's could be used to identify different levels of success. For example, the primary MOE for the sample scenario could be to deter the invasion. If this was not successful, secondary MOE's could be used to determine if the friendly forces were able to hold the invasion.

A generalized set of MOE's cannot be established for use in all OPLAN's. The MOE's for mission accomplishment will vary from OPLAN to OPLAN and from theater to theater within an OPLAN. Examples of MOE's are provided in this section but should not be taken as guidance for evaluations.

One example of a mission assignment in an OPLAN is the defense of a specified area, such as a city or a mountain pass. The purpose of the mission could be either to prevent the enemy from moving into the specified

area or to protect a sensitive target within the area. In the first case, the MOE could be the containment of enemy forces some specified distance from the area of defense within a determined loss percentage of friendly forces. This MOE could be evaluated by determining if the following statement is true or false:

number of enemy forces moving into the area by day C+30 < 1000

AND

percentage of out of action friendly forces defending the area < 10 %

In the second case, the MOE could be the successful protection of the specified target within a determined loss percentage of friendly forces. For example:

damage sustained by the specified target by day C+40 < 10 %

AND

percentage of out of action friendly forces defending the target < 8 %

Another example of an assigned mission is to secure a specified area from enemy forces. The MOE for this mission could be:

number of enemy forces remaining in designated area on day C+35 < 800

AND

percentage of out of action friendly forces securing area by day C+35 < 12%

Care must be taken when establishing MOE's. The easiest way to minimize the number of friendly forces killed or wounded during an operation is to put no friendly forces at risk.

The primary purpose of OPLAN evaluation of mission accomplishment at the theater level should not be how the mission was accomplished, i.e. tactics, but rather whether the assigned missions can be accomplished with the available forces and supplies. The level of detail in JTLS is sufficient for evaluating strategy but not, in most cases, for evaluating tactics. JTLS can possibly be used to evaluate the mission oriented assignments in OPLAN's for Army and Air Force units. In its current form, naval missions cannot be adequately evaluated.

2. Operation Plan Assumptions

All OPLAN's list within their documentation the assumptions upon which the plan is based. The plan assumptions vary from the level of host nation support and the availability of forces to the status of prepositioned supplies in the theater of operations and concurrent operations. The

assumptions are presented in the plan but the sensitivity of the success of the plan based on the assumptions is not assessed. One way to evaluate a plan assumption or set of assumptions is to execute two series of war games; one series evaluating the plan when the assumption(s) is true and another series when the assumption(s) is false. To adequately evaluate an assumption or set of assumptions, the remaining game parameters, data, strategy, etc. should remain relatively stable from one game play to the next. Some changes in game play may result due to reactions to different outcomes in the theater.

In some cases, evaluating assumptions may not require the play of two complete series of war games. For example, some assumptions may affect only the capability of units to reach their specified destinations. Only the initial deployment phase would be required to evaluate these types of assumptions. Other assumptions may affect units or activities during the middle of operations. In these cases, the initial war game should be played until the point where the assumption comes to bear and then the game should be saved. Starting from this saved position, the two series should then be played to identify any major differences in the outcomes of the two scenarios. Again, the Evaluation Team should attempt to stabilize the remaining variables in order to more fully justify the evaluation results.

3. Critical Supply Items

Many OPLAN's have designated certain supply items or categories as critical to the successful execution of the plan. Most items are designated as critical due to the military-wide shortages of the items, such as some types of missiles. Other items are critical because of the specific theater of operations. One example is water in a desert theater.

The structure for identifying the supply categories is designed in JTLS, but the specification of the different categories is a user variable and is defined in the data base. There is no limit on the number of supply categories that can be defined in JTLS. This design allows for the designation of supply classes as shown in Figure 2-4, designation based on the plan's critical supply items, or a combination of both. The recommended procedure is to use the combination approach. This approach would allow for the inclusion of all major supply classes. Supply classes which contain critical items could be further broken down to provide the required visibility. For example, critical supply items, such as missiles and water, could be specified as distinct supply categories in the war game. This will allow the evaluators to track the consumption and resupply of these items and to determine if the available supplies are adequate.

Supply shortages, especially in weapons systems and ammunition, can have a severe impact on the combat effectiveness of the forces. These shortages can be caused by limited supplies in the theater or by limited intratheater lift available to move the supplies to the units. To determine the effect of shortages, portions of the war game can be replayed with more limited supplies of specific supply categories or with a reduction of the lift capability of the supply depots. The Evaluation Team can use the resulting data to determine the sensitivity of mission accomplishment on the availability of personnel and materiel or lift assets. Much data is automatically collected in the Major Event History File and is identified in Chapter III, Section B.

4. Unit Movements to Destinations

The movement of units from their theater POD to their destination can be evaluated using JTLS. Within the theater, units are moved utilizing their own organic lift assets or the theater lift assets of the theater commander. A unit's organic lift capability is defined in the JTLS data base in terms of its wet and dry carry capacity and the unit's average speed. This speed is modified based on the characteristics of the terrain over which the unit is transiting and the density of units within the hexes. JTLS also has the capability of providing both airlift and sealift for forces within the

theater. Airlift and sealift load and off-load times are defined in the data base. The airlift and sealift functions can be used to simulate the lift resources of the theater commander.

JTLS is not capable of determining the optimal transportation flow for movements within the theater. The preferred mode and source of transportation for movement requirements is designated in the TPFDD. The modes are identified as land, air, or sea and the source is identified as either the unit's organic assets or the assets of the supported commander.

The TPFDD specifies the time the unit is required at the destination (required delivery date) for each unit in the plan. One possible MOE could be whether or not the units were at their destinations by the required time. Other MOE's could be the percentage of units at their destination by their required delivery dates or the average number of days a unit was late.

C. SUMMARY

Every evaluation, just as every OPLAN, is different and will vary depending on what aspects of the plan are to be evaluated. Based on my experience, JTLS in its current form is adequate for evaluating some aspects of operation plans such as land and air forces and their assigned missions. Naval missions can not be sufficiently evaluated with JTLS and

should be evaluated separately. In addition, most special operations are not simulated in JTLS. The effects of special forces could be input to the game through modifications to the data base.

JTLS can accommodate a broad range of activities but it is the responsibility of the Game Director to determine what should be evaluated. The Game Director, with the aid of the Evaluation Team must carefully analyze the variability of the results to determine their validity. The Game Director should initially attempt to evaluate some subset of assumptions or activities in an OPLAN during the evaluation cycle. A series of games should be evaluated and the results should be used as inputs to the new version of the plan.

VI. RECOMMENDATIONS AND CONCLUSIONS

In excess of one year and many man years are required to produce a complete operation plan and its supporting plans and annexes. A full evaluation of a plan should not be attempted during a one- or two-week war game. The evaluation should be accomplished through a series of structured war games. A war game should be viewed as just one tool in the total evaluation process. Recommended enhancements to JTLS, follow-on efforts in the evaluation process, and conclusions are outlined in the following sections.

A. RECOMMENDED ENHANCEMENTS FOR JTLS

There are several functional activities that are either not included in JTLS or are not designed in enough detail to allow for operation plan evaluation. The areas that require further design and study are the naval functions, C3, and the modeling of the effects of medical supplies and facilities within the theater of operations. These areas are discussed in detail in the succeeding sections.

1. Naval Functions

The naval functions are the least developed areas of JTLS and thus require the most effort. Areas that need to be enhanced or incorporated include amphibious landings, submarine and anti-submarine warfare, positioning of naval forces relative to the aircraft carrier or other designated unit, and ships' weapons systems.

The current version of JTLS does not have the capability of simulating amphibious landings in the theater. Ships are able to load and off-load units and their accompanying equipment and supplies, simulating the activities of sealift missions. In order to simulate amphibious landings, the combat events in an opposed landing must be included in the model.

Submarine forces, a major element of naval forces, are not modeled in JTLS. In addition, anti-submarine warfare (ASW) forces are similarly not modeled. These forces can have a significant impact on the successful execution of operation plans and thus their effect must be included during the evaluation of plans at least on an aggregate level.

The air module of JTLS permits players to specify the orbits of certain types of missions, i.e., combat air patrol, refueling missions, and AWACS. These orbits are specified by the starting and ending latitude and longitude. The orbits of naval air missions are normally specified relative

to their home base, i.e., the aircraft carrier or another designated unit. This allows the aircraft to remain in position relative to the unit as the unit is moving. JTLS should provide the capability of relative positioning for naval air units. In addition, other naval forces should also have the capability to station themselves around another unit to more closely approximate the operating procedures within a battle group. An aircraft carrier without its aircraft and escort ships is an easy target for enemy surface, subsurface, and air forces.

Ships have the capability to fire missiles in JTLS but the only variables provided are the number of missiles to be fired and their bearing. This capability should be increased to allow for the identification of the type of missile to be fired and the range.

These discrepancies in the naval function of JTLS must be remedied before a valid evaluation of operation plans which include naval forces can be accomplished.

2. Command, Control, and Communications Functions

JTLS contains a limited representation of command, control, and communications activities within the theater. Orders are sent to units by the theater commander. The time required for orders to reach the unit depend on the unit's physical distance from higher headquarters and its

organic C3 capability. Depending on the type of unit and its communication equipment, the physical distance may not have an effect in the real world. JTLS should allow for this type of capability by eliminating the distance effect on the unit if specified.

Communication between units other than the headquarters of the theater commander is not modeled in JTLS. The communication difficulties between units of different services is not represented and cannot be evaluated. JTLS does not model the problems of interoperability between forces. In a joint arena, interoperability of forces can have a significant effect on mission accomplishment. This is a nontrivial area and may not be appropriate for theater-level evaluations. More analysis is required to determine the impact on JTLS of implementing this enhancement.

3. Medical Functions

Medical planning cannot be adequately evaluated with JTLS. Personnel are treated as one of the combat systems. When a unit has sustained damage, some of the damage can usually be fixed and the amount is determined by the fraction of combat losses repairable in a specific supply category and the number of combat losses in a supply category that can be fixed per combat assessment interval. This is a very simplified way to measure the effects of medical supplies and facilities on wounded

personnel in the theater. The determination of the number of wounded that are able to return to the unit should be revised to depend on a medical supply category, such as bridge repair is currently evaluated. It should also depend on the level of medical facilities available within the theater of operations.

B. FOLLOW-ON EFFORTS

This thesis has proposed a structure for the evaluation of operation plans using JTLS. The required activities have been defined and sample activities have been examined. Additional effort is required before JTLS can be used to evaluate plans. A major effort involves building and validating the required data bases. One important task is the determination and validation of Lanchester attrition coefficients for use in the model. Valid probabilities of kill and damage also need to be determined for use in evaluations. Sample data bases should be prepared to use as the building blocks for evaluations. Once these activities have been accomplished, test evaluations should be performed to determine the time and resource requirements, as well as the data sensitivities.

C. CONCLUSIONS

The purpose of evaluation of operation plans with JTLS, or any war game, is to attempt to provide insights into the key assumptions and limitations of the plans. The purpose is not to determine an optimum military strategy nor should it be an evaluation of the players. The results of war games will not prove anything. Instead, they should be used to identify general trends during execution, not specific outcomes.

JTLS has excellent potential as a war game for use in evaluations. A final determination of its value should come only after the enhancements and follow-on efforts identified above are accomplished.

APPENDIX A

GLOSSARY

1. **ADEQUACY**. Operation plan review criterion. The scope and concept of planned operations are sufficient to accomplish the task assigned. (JOPS)
2. **ALLOCATION**. The resources provided to the commander of a unified or specified command by the JCS for execution planning or actual execution. (JOPS)
3. **ANNEXES**. Documents appended to the basic plan or order to make it clearer or to give further details. (AFSC)
4. **APPORTIONMENT**. The resources made available to the commander of a unified or specified command for deliberate planning. Apportioned resources are used in the development of operation plans and may be more or less than those allocated for execution planning or actual execution. (JOPS)
5. **ASSIGNED FORCES**. Forces in being which have been placed under the operational command or operational control of a commander. (JCS Pub 1)

6. **AUGMENTATION FORCES**. Forces to be transferred to the operational command of a supported commander during the execution of an operation. (JOPS)

7. **BASIC PLAN**. That part of an operation plan which forms the basic structure for annexes and appendices. It consists of general statements related to the situation, mission, execution, logistics, administration, and command and signal. (AFSC)

8. **CIVIL ENGINEERING SUPPORT PLANNING**. That part of operation plan development which plans the improvement or expansion of resources and facilities in the area of operations. (AFSC)

9. **COMMAND AND CONTROL**. The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. C2 functions are performed through an arrangement of personnel, equipment, communication facilities, and procedures that are employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. (JOPS)

10. **COMPONENT COMMANDER**. The senior officer of each Service assigned to a unified command (except for the unified commander and members of his joint staff) and qualified for command by the regulations of his

Service unless another another officer is so designated by competent authority. (UNAAF)

11. **COMPONENT COMMAND**. The component commander and all those individuals, units, detachments, organizations, or installations under the component commander's military command which have been assigned to the operational command of the commander of the unified command. (UNAAF)

12. **CONPLAN**. An operation plan in an abbreviated format which would require considerable expansion or alteration to convert it into an OPLAN or OPORD. (JOPS)

13. **CONCEPT OF OPERATIONS**. A verbal or written statement, in broad outline, of a commander's assumptions or intent in regard to an operation or series of operations. The concept is designed to give an overall picture of the operation. (JCS Pub 1)

14. **DELIBERATE PLANNING**. Operation planning as a result of JSCP or other tasking directive using JOPS Volumes I, II, and III procedures. (JOPS)

15. **DEPLOYMENT DATA BASE**. The JDS data base containing the necessary information on forces, material, and filler and replacement personnel movement requirements to support execution. The data base

reflects information contained in the refined TPFDD or data developed during the various phases of the Crisis Action System and the movement schedules or tables developed by the TOA's to support the deployment of required forces, personnel, and materiel. (JOPS)

16. **DEPLOYMENT PLANNING**. That part of operation planning which concerns the relocation of forces to the designed area of operation. (AFSC)

17. **EMPLOYMENT PLANNING**. That part of operation planning which concerns the strategic or tactical use of forces and materiel within the area of operations. (AFSC)

18. **FEASIBILITY**. Operation plan review criterion. The assigned tasks could be accomplished by utilizing available resources. (JOPS)

19. **FORCE LIST**. The total list of forces required by an operation plan, including assigned forces, augmentation forces, and other forces to be employed in support of the plan. (JOPS)

20. **FORCE MODULE**. A grouping of combat, combat support, combat service support forces, together with their appropriate non-unit-related personnel and supplies, for a specified period of time, usually 30 days. The elements of force modules are linked together or uniquely identified so that they may be extracted from or adjusted as an entity

in the TPFDD to enhance flexibility and usefulness of the operation plan during a crisis.

21. **GROSSLY TRANSPORTATION FEASIBLE**. A determination made by the supported commander that a draft OPLAN can be supported with the apportioned transportation assets. This determination is made by utilizing the TFE to simulate movement of personnel and cargo from POE to POD within a specified time frame. This permits submission of a draft OPLAN and supporting TPFDD to JCS and appropriate agencies for review prior to the Phase I TPFDD Refinement Conference. (JOPS)

22. **JOINT DEPLOYMENT AGENCY**. The JDA supports the JCS and supported commanders in planning for and executing deployments. As directed by the JCS, the JDA is responsible for coordination of deployment planning and execution in accordance with terms of reference for the JDA, and will act as the focal point for deployment associated decisionmaking. During peacetime deliberate planning, the JDA will interact with the JDC and coordinate deployment activities relating to the development, refinement, and maintenance of operation plans, deployment exercises, and establishment of necessary interfaces and procedures for wartime. (JOPS)

23. **JOINT DEPLOYMENT COMMUNITY**. Those headquarters, commands, and agencies involved in training, preparation, movement, reception, employment, support, and sustainment of military forces assigned or committed to a theater of operations or objective area. The JDC usually consists of the OJCS, Services, certain Service major commands (including the Service wholesale logistics commands), unified and specified commands (and their Service component commands), TOA's, JDA, joint task forces (as applicable), DLA, and other Defense agencies (e.g., DIA) as may be appropriate to a given scenario. (JDS)

24. **JOINT DEPLOYMENT SYSTEM**. The JDS consists of personnel, procedures, directives, communications systems, and electronic data processing systems to directly support time-sensitive planning and execution and to complement peacetime deliberate planning. (JDS)

25. **LIMITING FACTOR**. A factor or condition that, either temporarily or permanently, impedes mission accomplishment. Illustrative examples are transportation network deficiencies, lack of in-place facilities, malpositioned forces or materiel, extreme climatic conditions, distance, transit/overflight rights, political conditions, etc. (JOPS)

26. **MOVEMENT SCHEDULE.** A schedule developed to monitor or track a separate identity whether it is a force requirement, cargo or personnel increment, or lift asset. The schedule reflects the assignment of specific lift resources (such as an aircraft or ship) that will be used to move the personnel and cargo included in a specific movement increment. Arrival and departure time at POE, etc., are detailed to show a flow and workload at each location. Movement schedules are detailed enough to support plan implementation. (JOPS)

27. **MOVEMENT TABLE.** A table prepared by the TOA's for each force requirement and each non-unit-related personnel or cargo increment of the TPFDD concerning the scheduled movement from the origin or POE, intermediate location, and POD or destination. It is based on the estimated or planned availability of lift resources and, hence, is not an execution document. (JOPS)

28. **MOBILIZATION.** The process by which the Reserve Forces, or part of them, are brought to a state of readiness for war or other national emergency. This includes assembling and organizing personnel, supplies, and materiel for active military service. (JCS Pub 1)

29. **NATIONAL COMMAND AUTHORITIES.** The NCA consists of the President and the Secretary of Defense or their deputized alternates or successors. (JCS Pub 1)

30. **NON-UNIT-RELATED CARGO.** All equipment and supplies requiring transportation to an area of operation, other that those identified as the equipment of accompanying supplies of a specific unit (e.g., resupply, military support for allies, and support for nonmilitary programs, such as civil relief). (JOPS)

31. **NON-UNIT-RELATED PERSONNEL.** All personnel requiring transportation to or from an area of operations, other than those assigned to a specific unit. Examples are filler personnel replacements, temporary duty/temporary additional duty civilians, medical evacuees, and retrograde personnel. (JCS Pub 1)

32. **OPERATION ORDER.** A directive issued by a commander to subordinate commanders for the purpose of effecting coordinated execution of an operation. (JCS Pub 1)

33. **OPERATION PLAN.** Any plan, except the SIOP, for the conduct of military operations in a hostile environment prepared by the commander of a unified or specified command in response to a

requirement established by the JCS. Operation plans are developed in complete or concept format. (JOPS)

34. **PLAN MAINTENANCE**. The process that allows a supported commander to incorporate changes to the TPFDD that have occurred since TPFDD refinement. Plan maintenance is conducted by teleconference via the WWMCCS Intercomputer Network. At a minimum, the initial portion of the TPFDD is updated to insure currency of deployment data. Plan maintenance may also be used to update a TPFDD for JCS/JSCP submission in lieu of refinement. (JOPS)

35. **SHORTFALL**. The lack of forces, equipment, personnel, materiel, or capability -- apportioned to and identified as a plan requirement -- that would adversely affect the command's ability to accomplish its mission. (JOPS)

36. **SUBORDINATE COMMANDER**. A commander under the operational command of either a Supported or Supporting Commander, normally a Service component commander or the commander of a subordinate unified commandor subordinate joint task force. (JOPS)

37. **SUPPORTED COMMANDER**. The commander having primary responsibility for all aspects of a task assigned by the JSCP or by other authority. This term also refers to the commander who originates

OPLAN's in response to the requirements of the Joint Chiefs of Staff. (JOPS)

38. **SUPPORTING COMMANDER.** A commander who provides augmentation forces or other support to a supported commander or develops a supporting plan. Includes the TOA's, as appropriate. (JOPS)

39. **SUPPORTING FORCES.** Forces stationed in or to be deployed to an area of operations to provide support for the execution of an OPORD approved by the Joint Chiefs of Staff. Operational command of supporting forces is not passed to the supported commander. (JOPS)

40. **SUPPORTING PLAN.** An operation plan prepared by a supporting commander or a subordinate commander to satisfy the requests or requirements of the supported commander's plan. (JOPS)

41. **TIME-PHASED FORCE DEPLOYMENT DATA.** The computer-supported data base por- tion of an operation plan; it contains time-phased force data, nonunit-related cargo and personnel data, and movement data for the operation plan, including: (JOPS)

a. In-place units

b. Units to be deployed to support the OPLAN with a priority indicating the desired sequence for their arrival at the ports of debarkation.

c. Routing of forces to be deployed.

d. Movement data associated with deploying forces.

e. Estimates of non-unit-related cargo and personnel movements to be conducted concurrently with the deployment of forces.

f. Estimate of transportation requirements that must be fulfilled by common-user lift resources as well as those requirements that can be fulfilled by assigned or attached transportation resources.

42. **TPFDD REFINEMENT**. A two-phased process that identifies specific forces, incorporates accurate movement requirements for the first ninety days of a TPFDD, and insures that the deployment transportation requirements for the TPFDD are within the capabilities defined in JCS guidance. The process is administered by JDA in coordination with the supported commander, supporting commanders, Services, TOAs, and other agencies. TPFDD refinement is a JDS procedure that complements JOPS procedures for selected operation plans and occurs during the JOPS plan development phase. (JOPS)

43. **TIME-PHASED FORCE DEPLOYMENT LIST**. Appendix 1 to Annex A of the OPLAN. Identifies types and/or actual units required to support the OPLAN and indicates origin and POD's or ocean area. May also be generated as a computer listing from the TPFDD.

APPENDIX B

ABBREVIATIONS AND ACRONYMS

ADP	Automatic Data Processing
ALD	Available to Load Date
AMP	Air Mission Package
APORTS	Aerial Ports and Air Operating Bases File
ASSETS	Transportation Assets File
ASW	Anti-submarine Warfare
AWACS	Airborne Warning and Command Center
C2	Command and Control
C3	Command, Control, and Communications
CAA	Concepts Analysis Agency
CAP	Combat Air Patrol
CAS	Close Air Support
CEF	Civil Engineering File
CEP	Combat Events Program
CESPG	Civil Engineering Support Plan Generator
CHSTR	Characteristics of Transportation Resources File

CINC	Commander in Chief
CINCPACFLT	Commander in Chief, United States Pacific Fleet
COA	Course of Action
CONPLAN	Operation Plan in Concept Format
CPX	Command Post Exercise
DBPT	Data Base Preparation Team
DCL	DEC Command Language
DEC	Digital Equipment Company
DIA	Defense Intelligence Agency
DLA	Defense Logistics Agency
DoD	Department of Defense
EAD	Earliest Arrival Date
EC	Electronic Combat
FRG	Force Requirements Generator
HUMINT	Human Intelligence
IMAPS	Integrated Military Airlift Planning System
JAD	Joint Analysis Directorate
JCS	Joint Chiefs of Staff
JDA	Joint Deployment Agency
JDC	Joint Deployment Community

JDS	Joint Deployment System
JOPS	Joint Operation Planning System
JSCP	Joint Strategic Capabilities Plan
JSPS	Joint Strategic Planning System
JTLS	Joint Theater Level Simulation
LAD	Latest Arrival Date
LFF	Logistics Factors File
MAC	Military Airlift Command
MAPS	Mobility Analysis and Planning System
MIP	Model Interface Program
MOE	Measure of Effectiveness
MPM	Medical Planning Module
MRG	Movement Requirements Generator
MSC	Military Sealift Command
MTM	McClintock Theater Model
MTMC	Military Traffic Management Command
NBC	Nuclear, Biological, and Chemical
NCA	National Command Authority
NPS	Naval Postgraduate School
OJCS	Organization of the Joint Chiefs of Staff

OPLAN	Operation Plan in Complete Format
OPORD	Operation Order
POD	Port of Debarkation
POE	Port of Embarkation
POL	Petroleum, Oil, and Lubricants
PORTS	Port Characteristics File
PPBS	Planning, Programming, and Budgeting System
QRA-DCA	Quick Reaction Alert - Defensive Counter Air
QRA-OAS	Quick Reaction Alert - Offensive Air Support
RDD	Required Delivery Date
RECCE	Reconnaissance
REM	REDCOM Element Monterey
RLD	Ready to Load Date
SEACOP	Strategic Sealift Contingency Planning System
SPP	Scenario Preparation Program
S/RP	Start/Restart Program
TFCA	Total Force Capability Assessment
TFE	Transportation Feasibility Estimator
TOA	Transportation Operating Agency
TO&E	Table of Organization and Equipment

TPFDD	Time-Phased Force Deployment Data
TUCHA	Type Unit Data
TUDET	Type Unit Equipment Detail File
USAWC	United States Army War College
USREDCOM	United States Readiness Command
WWMCCS	Worldwide Military Command and Control System

APPENDIX C

WAR GAME CHECKLISTS

Pre-War Game Activities	Responsibility	Date Required in Advance of War Game
Define objectives of the evaluation.	Game Director	95
Define activities, assumptions, etc. to be evaluated.	Game Director	95
Define the MOE's.	Evaluation Team	90
Define the game structure.	Evaluation Team	90
Acquire or build terrain data.	DBPT	35
Define units and their characteristics.	DBPT	35
Define supply categories.	DBPT	35
Define weapon systems.	DBPT	35
Define attrition coefficients.	DBPT	35
Define target list.	DBPT	35
Prepare the data base in JTLS format.	DBPT	21
Define data collection requirements and method.	Evaluation Team	21
Define required actions by the Blue and Red Teams.	Evaluation Team	14

Prepare game book for participants.	Game Director	7
Identify data base modifications required during game play.	Evaluation Team	7
Exercise the data base and check for realism.	DBPT	7
Prepare the Blue and Red Team notebooks.	DBPT	4

War Game Activities	Responsibility
Act as higher authority for Blue and Red Teams.	Game Director
Collect required data.	Evaluation Team
Monitor actions and modify events.	Evaluation Team
Start, restart, and save JTLS.	Controller/Support Group
Keep the Game Director and Evaluation Team informed of game truth.	Controller/Support Group
Ensure Blue and Red Teams are following guidance.	Controller/Support Group
Set game speed and redefine parameters.	Controller/Support Group
Translate blue and red requirements into directives and provide results.	Controller/Support Group
Move units, initiate force actions, and react to the war game.	Blue and Red Teams
Provide comments to the Game Director.	All

Post-War Game Activities	Responsibility
Analyze data and comments.	Evaluation Team
Identify weaknesses and limitations.	Evaluation Team
Identify areas for further evaluation.	Evaluation Team
Prepare final evaluation report.	Evaluation Team
Approve evaluation report.	Game Director
Provide evaluation report to appropriate action officers for consideration in next plan development cycle.	Game Director

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